VOLUME 7 JANUARY 1958 • NUMBER 1

A.M.A. ARCHIVES OF SURGERY

Experimental Nylon Aortic Substitutes
William O. Barnett

Congenital Bilobed Gallbladder
Raymond E. Anderson and Weldon T. Ross

Surgical Management of Chronic Ulcerative Colitis
William S. Carpenter and Paul J. Connolly

Complete Homotransplantation of Canine Heart and Lungs
Gumersindo Blanco, Alberto Adam, David Rodriguez-Perez, and Agustin Fernandez

Tendon Transfer for Old Radial Nerve Paralysis
Harold R. Brodman

Complications of Aortography
James E. Anthony Jr.

Surgery in Conjoined Twins
Edward W. Jenkins, T. Richard Watson, and William T. Mosenthal

Effect of Permanent Alteration of Hepatic Blood Flow upon Biliary Secretion
Bernard Fisher, Sil H. Lee, and E. J. Fedor

Chylothorax Treated by Ligation of the Thoracic Duct and Studies in Thoracic Ductography
Joseph J. Garamella

Hazards of Arteriography
P. H. Klingenberg

Use of Lyophilized Homografts of Dura Mater in Repair of Incisional Hernias
Francis C. Usher

Bilateral Pheochromocytoma
Richard H. Flandreau and Arthur S. Glushien

Influence of Infection on Homografts and Synthetic (Teflon) Grafts
J. Harold Harrison

Subtotal Gastric Resection for Benign Peptic Ulcer
Newlin Hastings, James A. Halsted, Edward R. Woodward, Marvin Gasster, and Elva A. Hiscock

Pulmonary Leiomyosarcoma
Thomas H. Hewlett and James E. McCarty

Carcinoma of the Parathyroid
George L. Jordan Jr., George W. Curd, Ferenc Gyorkey, and Michael E. DeBakey

Prescalene Lymph Node Biopsy
Burrill N. Josephs and Francis M. Woods

Traumatic Pseudocyst Formation of the Parotid Duct
Rudolph M. Landry

Carcinoma of the Breast Associated with Discharge from the Nipple but No Palpable Mass
Herbert E. Madalin, F. Henry Ellis Jr., and John R. McDonald

Collateral Circulation to the Heart by Means of Cardiopneumonopexy and Lingular Vein Ligation
Roman J. Kownacki, Vincent P. Kownacki, Arthur J. Kennel, Joseph E. Imbriglia, and William L. Martin

Hydatid Cyst of the Liver Producing Massive Gastrointestinal Hemorrhage
James S. O'Hare

Venous Angiocardiographic Diagnosis of Acute Dissecting Hematoma of Aorta (Dissecting Aneurysm)
Louis A. Soloff, Jacob Zatuchni, Herbert M. Stauffer, and R. Robert Tyson

Pain Control Following Hemorrhoidectomy
Howard D. Trimpi and Guy L. Kratzer

Carcinoma Arising in Sebaceous Cysts
Jack W. Welch

Traumatic Laceration of the Coronary Arteries
J. P. Woodhall

Injuries of the Trachea
A. Richard Gray, John M. Howard, William H. Harrison Jr., and Cecil M. Cowes

Pilonidal Cyst—Neither Pilonidal Nor Cyst
Robert M. Hardaway

Calcified Pseudocyst of the Spleen
George F. Asbury

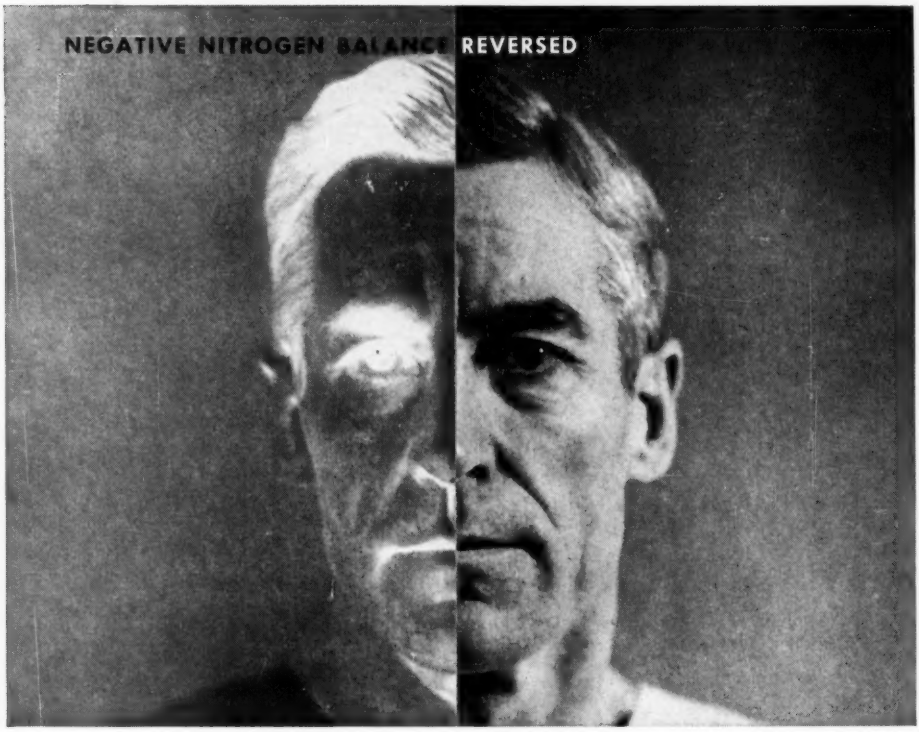
Leiomyosarcoma of the Spermatic Cord
Kenneth Cruze

Cystic Lymphangioma of the Mesentery
Jack A. Lawson, Ronald B. Dietrick, and Simon Russi

Mammary Carcinoma Followed After Twenty-Eight Years by Primary Malignant Pleural Mesothelioma
R. Drew Miller, Malcolm B. Dockerty, and Warren A. Bennett

Complete Contents on First Inside Page

AMERICAN MEDICAL ASSOCIATION PUBLICATION



Nilevar®

stimulates protein synthesis, corrects negative nitrogen balance

Increased nitrogen loss, with resulting negative nitrogen balance, occurs in infection, trauma, major surgery, extensive burns, certain endocrine disorders and starvation and emaciation syndromes. The intrinsic control of protein metabolism is lost and a protein "catabolic state" occurs. A patient requiring more than ten days of bedrest usually has had sufficient metabolic insult[1] to precipitate such a "catabolic" phase.

Nilevar (brand of norethandrolone) has been used in patients with varied conditions including hyperthyroidism, poliomyelitis, aplastic anemia, glomerulonephritis, anorexia nervosa and postoperative protein depletion. The patients gained weight and felt better. It was concluded[2] that "the drug certainly caused a reversal of rather recalcitrant or progressive catabolic patterns of disease."

Nilevar is unique among anabolic steroids in that androgenic side action is minimal or absent.

The suggested adult dosage is three to five tablets (30 to 50 mg.) daily. For children 1.5 mg. per kilogram of weight is recommended.

G. D. Searle & Co., Chicago 80, Illinois. Research in the Service of Medicine.

---

1. Axelrod, A. E.; Beaton, J. R.; Cannon, P. R., and others: Symposium on Protein Metabolism, New York, The National Vitamin Foundation, Incorporated, (March) 1954, p. 100.

2. Proceedings of a Conference on the Clinical Use of Anabolic Agents, Chicago, Illinois, G. D. Searle & Co., April 9, 1956, pp. 32-35.

SEARLE

TABLE OF CONTENTS

VOLUME 76 JANUARY 1958 NUMBER 1

ORIGINAL ARTICLES

PAGE

Experimental Nylon Aortic Substitutes
William O. Barnett, M.D., Jackson, Miss. 1

Congenital Bilobed Gallbladder
Raymond E. Anderson, M.D., and Weldon T. Ross, M.D., McMinnville, Ore. 7

Surgical Management of Chronic Ulcerative Colitis
William S. Carpenter, M.D., and Paul J. Connolly, M.D., Detroit 13

Complete Homotransplantation of Canine Heart and Lungs
Gumersindo Blanco, M.D.; Alberto Adam, M.D.; David Rodriguez-Perez, M.D., and Agustin Fernandez, B.S., San Juan, Puerto Rico 20

Tendon Transfer for Old Radial Nerve Paralysis
Harold R. Brodman, M.D., New York 24

Complications of Aortography
James E. Anthony Jr., M.D., Chicago 28

Surgery in Conjoined Twins
Edward W. Jenkins, M.D.; T. Richard Watson, M.D., and William T. Mosenthal, M.D., Hanover, N. H. 35

Effect of Permanent Alteration of Hepatic Blood Flow upon Biliary Secretion
Bernard Fisher, M.D.; Sil H. Lee, M.D., and E. J. Fedor, Ph.D., Pittsburgh 41

Chylothorax Treated by Ligation of the Thoracic Duct and Studies in Thoracic Ductography
Joseph J. Garamella, M.D., Ph.D., Minneapolis 46

Hazards of Arteriography
P. H. Klingenberg, M.D., Dayton, Ohio 54

Use of Lyophilized Homografts of Dura Mater in Repair of Incisional Hernias
Francis C. Usher, M.D., Houston, Texas 58

Bilateral Pheochromocytoma
Richard H. Flandreau, M.D., Philadelphia, and Arthur S. Glushien, M.D., Pittsburgh 62

Influence of Infection on Homografts and Synthetic (Teflon) Grafts
J. Harold Harrison, M.D., Atlanta 67

Subtotal Gastric Resection for Benign Peptic Ulcer
Newlin Hastings, M.D.; James A. Halsted, M.D.; Edward R. Woodward, M.D.; Marvin Gasster, M.D., and Elva A. Hiscock, B.S., Los Angeles 74

Pulmonary Leiomyosarcoma
Lieut. Col. Thomas H. Hewlett (MC) and Capt. James E. McCarty (MC), U. S. Army 81

Carcinoma of the Parathyroid
George L. Jordan Jr., M.D.; George W. Curd, M.D.; Ferenc Gyorkey, M.D., and Michael E. DeBakey, M.D., Houston, Texas 87

Prescalene Lymph Node Biopsy
Burrill N. Josephs, M.D., and Francis M. Woods, M.D., Boston 93

Traumatic Pseudocyst Formation of the Parotid Duct
Rudolph M. Landry, M.D., Chattanooga, Tenn. 97

Carcinoma of the Breast Associated with Discharge from the Nipple but No Palpable Mass
Herbert E. Madalin, M.D.; F. Henry Ellis Jr., M.D., and John R. McDonald, M.D., Rochester, Minn. 100

Collateral Circulation to the Heart by Means of Cardiopneumonopexy and Lingular Vein Ligation
Capt. Roman J. Kownacki (MC), U. S. A. F.; Vincent P. Kownacki, M.D.; Arthur J. Kennel, M.D.; Joseph E. Imbriglia, M.D., and William L. Martin, M.D., Philadelphia 106

Hydatid Cyst of the Liver Producing Massive Gastrointestinal Hemorrhage
James S. O'Hare, M.D., Baltimore, Md. 113

Venous Angiocardiographic Diagnosis of Acute Dissecting Hematoma of Aorta (Dissecting Aneurysm)
Louis A. Soloff, M.D.; Jacob Zatuchni, M.D.; Herbert M. Stauffer, M.D., and R. Robert Tyson, M.D., Philadelphia 116

Pain Control Following Hemorrhoidectomy
Howard D. Trimpi, M.D., and Guy L. Kratzer, M.D., Allentown, Pa. 123

Carcinoma Arising in Sebaceous Cysts
Jack W. Welch, M.D., Halstead, Kan. 128

Traumatic Laceration of the Coronary Arteries
J. P. Woodhall, M.D., Macon, Ga. 133

Injuries of the Trachea
A. Richard Gray, M.D.; John M. Howard, M.D.; William H. Harrison Jr., M.D., and Cecil M. Cowes, M.D., Atlanta 138

(Continued on Next Page)

A. M. A.
ARCHIVES OF SURGERY

Also the Official Publication of the Central Surgical Association and the Western Surgical Association

VOLUME 76 JANUARY 1958 NUMBER 1

COPYRIGHT, 1957, BY THE AMERICAN MEDICAL ASSOCIATION

EDITORIAL BOARD

WALTMAN WALTERS, Chairman, Rochester, Minn.
LESTER R. DRAGSTEDT, Chicago

ARTHUR W. ALLEN, Boston
ALFRED BLALOCK, Baltimore
FRANK HINMAN Jr., San Francisco
G. E. LINDSKOG, New Haven, Conn.
WALTER MADDOCK, Chicago
ALTON OCHSNER, New Orleans
HENRY KING RANSOM, Ann Arbor, Mich.
HENRY SWAN, Denver
BARNES WOODHALL, Durham, N. C.

AUSTIN SMITH, Editor, A. M. A. Scientific Publications
GILBERT S. COOPER, Managing Editor, Specialty Journals

TABLE OF CONTENTS (Continued)

Pilonidal Cyst—Neither Pilonidal Nor Cyst
Lieut. Col. Robert M. Hardaway (MC), U. S. Army 143

CASE REPORTS

Calcified Pseudocyst of the Spleen
George F. Asbury, M.D., Bremerton, Wash. 148

Leiomyosarcoma of the Spermatic Cord
Kenneth Cruze, M.D., Los Angeles 151

Cystic Lymphangioma of the Mesentery
Jack A. Lawson, M.D.; Ronald B. Dietrick, M.D., and Simon Russi, M.D., Richmond, Va. 155

Mammary Carcinoma Followed After Twenty-Eight Years by Primary Malignant Pleural Mesothelioma
R. Drew Miller, M.D.; Malcolm B. Dockerty, M.D., and Warren A. Bennett, M.D., Rochester, Minn. 160

Retroperitoneal Liposarcoma with Hemorrhage
Clifton F. West Jr., M.D., Philadelphia 164

Hemorrhagic Telangiectasia (Rendu-Osler-Weber Disease)
Arkell M. Vaughn, M.D.; Michael S. White, M.D., and Gordon H. McCoy, M.D., Chicago 167

SCIENTIFIC EXHIBITS

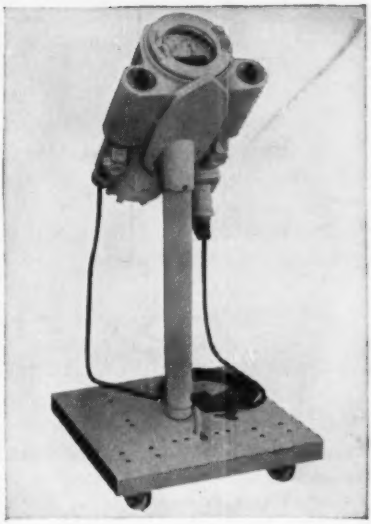
Technique for Extra-Articular Injection
Eugene G. Lipow, M.D., Washington, D. C.; Kenneth M. Kron, M.D., and Richard T. Smith, M.D., Philadelphia 171

Published monthly by the AMERICAN MEDICAL ASSOCIATION. Editorial and Circulation Offices: 535 North Dearborn Street, Chicago 10, Illinois. Publication Office: Thompson Lane, Box 539, Nashville 1, Tennessee. Change of Address: Notice to the circulation office should state whether or not change is permanent and should include the old address. Six weeks' notice is required to effect a change of address. Second-class mail privileges authorized at Nashville, Tenn., Aug. 6, 1956.

CAMBRIDGE OPERATING ROOM CARDIOSCOPE

Modern instruments for surgery

The Cambridge Operating Room Cardioscope continuously indicates to the Anesthesiologist and Surgeon any lead of the patient's electrocardiogram and the instantaneous heart rate or the patient's electroencephalogram. Its sweep second hand is most convenient for timing respiration and for similar purposes. A cardiac standstill alarm gives audible warning *instantly* the heart rate drops below a selected critical minimum. By simple operation of a remote control switch on the Cardioscope, any portion of any lead of the electrocardiogram or the EEG is recorded upon the Cambridge Simpli-Scribe Direct Writing Electrocardiograph located outside the Operating Room. In this manner, a continuous history of the patient's heart and of the depths of anesthesia can be recorded during the operation.



OPERATING ROOM CARDIOSCOPE

"SIMPLI-SCRIBE" DIRECT WRITER

The Cardioscope incorporates the recommendations of prominent Anesthesiologists, Cardiologists and Surgeons. The Simpli-Scribe Electrocardiograph is a fine portable direct writing instrument embodying the design and manufacturing skill of Cambridge, Availability of this combination of instruments may well decide whether surgery is justified upon a poor risk patient.

It is must equipment for the modern operating room.

Other Cambridge cardiac diagnostic instruments

CARDIAC CATHETERIZATION UNIT provides cathode screen monitoring and direct recording of intracardiac pressures and electrocardiogram or other functions as desired, simultaneously. Two, three or four channels may be provided.

AUDIO-VISUAL HEART SOUND RECORDER enables the Doctor to simultaneously HEAR, SEE and permanently RECORD heart sounds.

CAMBRIDGE MULTI-CHANNEL DIRECT WRITING RECORDER consists of two, three or four direct-writing galvanometers together with appropriate amplifiers, power supply and control panels, mounted on a single mobile cabinet. Multi-Channel String Galvanometer Instruments are also available.

CAMBRIDGE STANDARD STRING GALVANOMETER ELECTROCARDIOGRAPHS are available in the SIMPLITROL Portable Model, the Mobile Model, and the Research Model, all of which may be arranged for heart sound and pulse recording.

EDUCATIONAL CARDIOSCOPE is used in many of the leading medical schools for teaching electrocardiography and auscultation by audio-visual demonstration.

PLETHYSMOGRAPH—Records variations in volume of extremities as determined by the state of fullness of the blood vessels.

ELECTROKYMOGRAPH—Produces a continuous record of heart border motion at chosen points along the cardiac silhouette.

BLOOD PRESSURE RECORDER—A portable instrument which continuously indicates and records blood pressure.

AMPLIFYING STETHOSCOPE— A pocket-size, lightweight instrument for auscultation of amplified heart sounds and murmurs for normal and hard-of-hearing physicians.

RESEARCH pH METER—For biological and medical research. Sensitive to .005 pH, readings reproducible to .01 pH.

GAS ANALYZER FOR RESPIRATORY RESEARCH.

Send for descriptive literature

CAMBRIDGE INSTRUMENT CO., INC.

3054 Grand Central Terminal, New York 17

CHICAGO 39, ILL. 4000 West North Ave. | CLEVELAND 15, OHIO 1720 Euclid Avenue | DETROIT 2, MICHIGAN 7410 Woodward Ave. | PHILADELPHIA 4, PA. 135 South 36th St.

PIONEER MANUFACTURERS OF THE ELECTROCARDIOGRAPH

Instructions to Contributors

Articles, book reviews, and other materials for publication should be addressed to the Chief Editor. Articles are accepted for publication on condition that they are contributed solely to this journal.

An original typescript of an article, with one carbon copy, should be provided; it must be double or triple spaced on one side of a standard size page, with at least a 1-inch margin at each edge. Another carbon copy should be retained by the author.

The main title of an article may not contain more than eighty characters and spaces; a subtitle may be of any length.

The author's name should be accompanied by the highest earned academic or medical degree which he holds. If academic connections are given for one author of an article, such connections must be given for all other authors of the article who have such connections.

If it is necessary to publish a recognizable photograph of a person, the author should notify the publisher that permission to publish has been obtained from the subject himself if an adult, or from the parents or guardian if a child. An illustration that has been published in another publication should be accompanied by a statement that permission for reproduction has been obtained from the author and the original publisher.

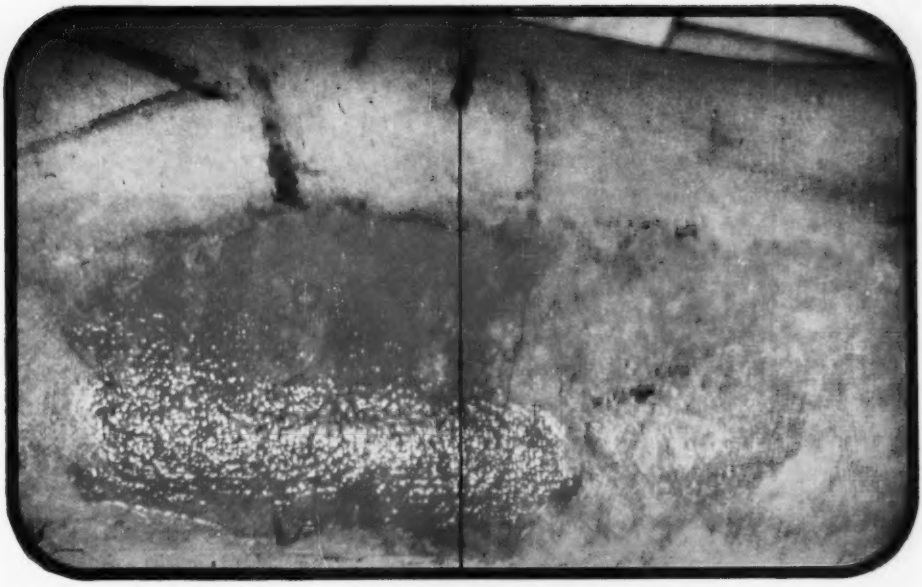
Oversized original illustrations should be photographed and a print on glossy paper submitted. Prints of a bluish tinge should be avoided. Large photomicrograph prints will be reduced in scale unless portions to be cropped are indicated by the author. The author should submit duplicate prints of roentgenograms and photomicrographs with the essential parts that are to be emphasized circled, as a guide to the photoengraver.

Charts and drawings should be in black ink on hard, white paper. Lettering should be large enough, uniform, and sharp enough to permit necessary reduction. Glossy prints of x-rays are requested. Paper clips should not be used on prints, since their mark shows in reproduction, as does writing on the back of prints with hard lead pencil or stiff pen. Labels should be prepared and pasted to the back of each illustration showing its number, the author's name, and an abbreviated title of the article, and plainly indicating the top. Charts and illustrations must have descriptive legends, grouped on a separate sheet. Tables must have captions. ILLUSTRATIONS SHOULD BE UNMOUNTED.

References to the literature should be limited to those used by the author in preparation of the article. They should be typed on a special page at the end of the manuscript. The citation should include, in the order given, name of author, title of article (with subtitle), name of periodical, with volume, page, month—day of month if weekly or biweekly—and year. References to books must contain, in the order given, name of author, title of book, city of publication, name of publisher, and year of publication.

AMERICAN MEDICAL ASSOCIATION

535 North Dearborn Street **Chicago 10**



Skin graft donor site after 2 weeks' treatment with ...

petrolatum gauze—still largely granulation tissue | FURACIN gauze—completely epithelialized

OBJECTIVE EVIDENCE OF EXCELLENT WOUND HEALING

was obtained in a quantitative study of 50 donor sites, each dressed half with FURACIN gauze, half with petrolatum gauze. Use of antibacterial FURACIN Soluble Dressing, with its water-soluble base, resulted in rapid and complete epithelialization. No tissue maceration occurred in FURACIN-treated areas; no sensitization was reported.

Jeffords, J. V., and Hagerty, R. F.: Ann. Surg. *145*:169, 1957.

FURACIN® . . . brand of nitrofurazone

a broad-range bactericide that is *gentle to tissues*

spread FURACIN Soluble Dressing: FURACIN 0.2% in water-soluble ointment-like base of polyethylene glycols.

sprinkle FURACIN Soluble Powder: FURACIN 0.2% in powder base of water-soluble polyethylene glycols. Shaker-top vial.

spray FURACIN Solution: FURACIN 0.2% in liquid vehicle of polyethylene glycols 65%, wetting agent 0.3% and water.

EATON LABORATORIES, NORWICH, N.Y.

Nitrofurans—a NEW *class of antimicrobials—neither antibiotics nor sulfonamides*

What is a Sensible Breakfast in Obesity?

IN the diet planned to reduce obesity it appears especially important that the total allowed calorie intake be well distributed over the day's customary three meals. A ratio of approximately 25% of the day's calories at breakfast, 35% at luncheon, and 40% at dinner has found wide acceptance.

Thus a sensible reducing regimen begins with a sensible breakfast—one which contributes a reasonable share of the day's total requirement of all essential nutrients, provides approximately one-fourth of the day's calories, and prevents undue hunger and helps maintain acuity during the morning hours.

A bowl of steaming oatmeal (¾ cup cooked oatmeal, 4 ounces skim milk, and 1 level teaspoon sugar) fits well into such a breakfast, whether the total calorie allowance be 1000, 1200, or 1600 calories per day.

Quaker Oats and Mother's Oats, the two brands of oatmeal offered by The Quaker Oats Company, are identical. Both brands are available in the Quick (cooks in one minute) and the Old-Fashioned varieties which are of equal nutrient value.

IN POSTSURGICAL NUTRITION oatmeal finds a well-merited place as soon as feedings no longer need be limited to clear liquids. Its high nutrient value and blandness aid in rapid, uneventful re-alimentation.

NUTRIENT CONTENT OF THE OATMEAL BREAKFAST SERVING

(¾ cup cooked oatmeal, 4 ounces skim milk, and 1 level teaspoon sugar)
Approximately 170 calories

Protein	9.0 Gm.	Folic acid	11.7 mcg.
Carbohydrate	28.0 Gm.	Iron	1.38 mg.
Fat	2.1 Gm.	Calcium	167 mg.
Thiamine	0.23 mg.	Phosphorus	235 mg.
Niacin	0.41 mg.	Potassium	325 mg.
Riboflavin	0.27 mg.	Zinc	1.53 mg.
Pyridoxine	0.13 mg.	Copper	0.35 mg.
Pantothenic acid	0.66 mg.	Manganese	1.45 mg.
Vitamin B_{12}	0.8 mcg.	Magnesium	65 mg.

A 300 calorie breakfast of 4 ounces of orange juice, the serving of oatmeal, a slice of lightly buttered toast, and coffee or tea (with artificial sweetener, if desired) is a sensible, satisfying, and nutritious morning meal in the reducing regimen.

The Quaker Oats Company
CHICAGO

In hip pinning...

Multiple radiographs are often desirable in order to show (a) reduction of the fracture, (b) placing of guide wires, (c) step-by-step location of the pin. Kodak Royal Blue Medical X-ray Film is ideal for this procedure. It's the fastest film available. In fact, experience shows that previously used MaS factors can generally be cut in half. Moreover, it extends the high-contrast characteristic to much greater density levels.

N.B. *To take full advantage of the speed of Royal Blue, it should be developed for 5 minutes at 68 F—or the equivalent. For top performance, use Kodak Liquid X-ray Developer and Replenisher or Kodak Rapid X-ray Developer.*

Order from your Kodak x-ray dealer

EASTMAN KODAK COMPANY
***Medical Division,* Rochester 4, N. Y.**

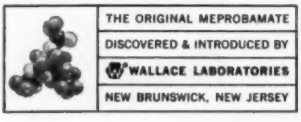
Kodak
TRADE MARK

Before and after surgery

effective for anxiety, tension and insomnia

- reduces preoperative fear
- helps ensure natural sleep without morning hang-over
- no significant lowering of blood pressure
- no respiratory depression
- well tolerated, relatively nontoxic

Miltown®



REFERENCES:

1. *Rushia, E. L.: Preliminary report on the use of meprobamate for pre-anesthetic sedation. J.M.A. Georgia* **46**:*93, March 1957.*
2. *Lamphier, T. A.: The role of meprobamate in postoperative surgical care. Ann. New York Acad. Sc.* **67**:*810, May 9, 1957.*
3. *Kern, E. C.: Preoperative sedation with meprobamate (Miltown) in surgery of eye, ear, nose and throat. Eye, Ear, Nose & Throat Month.* **36**: *408, July 1957.*

CH-6088

A.M.A. ARCHIVES OF
SURGERY

Experimental Nylon Aortic Substitutes

Results After Two Years' Implantation in the Dog

WILLIAM O. BARNETT, M.D., Jackson, Miss.

Pliable plastic aortic substitutes have enjoyed an increasing extension of use since the introduction of Vinyon N by Voorhees, Jaretzki, and Blakemore.[23] Complications have, in general, been meager; however, the many experimental studies concerning this subject include very few reports in which the follow-up period was as long as two years.[1,2,4-17,19-22,24] Recent evidence indicates a loss of as much as 80% of the strength of nylon six months after implantation.[8] The importance of the synthetic fabric itself as a part of the newly formed artery is emphasized by Shumacker's experience[18] in which removal of the plastic tube from a newly formed vessel was followed by aneurysm formation. The fibrous sheath alone was unable to maintain the integrity of the vessel wall when subjected to the pressure of the arterial system. In another instance, following resection of a large aortic aneurysm with insertion of a nylon graft, the upper suture line eroded into the duodenum, with fatal hemorrhage resulting.[3] A presentation of the results obtained up to two years after insertion of pliable plastic tubes into the abdominal aortas of 17 dogs (Table) follows.

Submitted for publication April 19, 1957.

Supported by a Grant from the Mississippi Heart Association.

Clinical Assistant Professor of Surgery, Department of Surgery, University of Mississippi Medical Center.

Experience with Nylon Aortic Substitutes

Animal No.	Length of Graft, Cm.	Diameter of Graft, Cm.	Type of Suture	Period of Observation,	Thrombosis	Result
1	5	1.0	O *	760	—	Good
2	5	0.8	O	725	—	Killed
3	5	0.8	O	245	—	Killed
4	5	0.8	O	375	—	Killed
5	5	0.8	O	30	—	Died (distemper)
6	5	0.8	O	3	—	Died (disruption of suture line)
7	5	0.8	O	515	—	Killed
8	4	0.8	E †	509	—	Killed
9	4	0.8	E	480	+	Killed
10	4	0.8	O	473	+	Killed
11	4	0.8	O	468	—	Killed
12	5	0.8	O	460	—	Killed
13	5	0.8	O	1	—	Killed
14	5	0.8	O	458	—	Killed
15	5	0.8	O	454	—	Killed
16	3	0.8	O	186	+	Killed
17	3	0.8	O	184	—	Killed

* Over-and-over type.
† Everting type.

Materials and Methods

Nylon filter fabric was used for the construction of these prostheses. Patterns of the desired dimensions were traced onto the surface of the cloth, after which they were cut along the outlined margins. The sides were then folded so as to form a cylinder, the shape of which was maintained by a seam of nylon thread. They were thoroughly washed with a detergent, rinsed in tap water, and allowed to dry. The ends were folded back, giving a cuff which facilitated sewing. They were sterilized in the autoclave along with the surgical instruments.

Healthy mongrel dogs were used for these experiments. Anesthesia was induced with intravenous pentobarbital. Utilizing sterile technique, the peritoneal cavity was opened through a lower midline abdominal incision. The intestine was packed into the upper abdomen, with excellent exposure of the aorta resulting. All branches of the aorta, from the renal arteries to the trifurcation, were divided and ligated. An aortic segment of the desired length was removed after Atraumatic clamps had been placed above and below. Anastomosis of a nylon tube with the host aorta was effected by continuous over-and-over sutures of 00000 arterial silk. The distal clamp was removed first, with resultant filling of the tube with blood. Bleeding through the pores of the cloth was minimal. Moderate blood loss from the sites of the anastomosis lasted from four to eight minutes but was easily controlled by external pressure. No anticoagulant therapy was used in these experiments. Before the abdominal wound was closed, the posterior peritoneum was carefully approximated over the plastic tubes so that they were completely surrounded by viable tissue. Antibiotics were not used; no evidence of hindquarter paralysis developed, and the animals were usually walking on the first postoperative day. Aortorgrams were made during injection of 70% sodium acetrizoate (Urokon) through a polyethylene tube which was introduced into the aorta retrogradely through a carotid artery. Cellular detail was obtained from microscopic sections stained with hematoxylin and eosin.

Results

Disruption of the proximal suture line, three days after insertion of a nylon graft, was the cause of death in Animal 6. The inadequacy of the anastomosis was recognized at the time of surgery. The second mortality occurred 30 days after operation and was the result of distemper. Occlusion of the prosthesis was found in three animals. When Animal 16 was killed, the nylon tube was found to be filled with thick, green pus. There was extensive reaction about the retroperitoneal space in the vicinity of the aorta. The aortic lumen ended abruptly at the proximal suture line, apparently from contraction of the anastomosis. Animals 9 and 10 appeared to be entirely normal at the time of killing. In spite of palpable femoral pulses in both animals, reoperation revealed occlusion of the nylon tubes. There was extensive reaction about the grafted area in both animals. The nylon tube was found inside a mass of fibrous tissue, having been detached from the distal anastomotic site. The distal 2 cm. of the proximal aortic lumen was only 2 mm. in diameter.

Animal 17 was of particular interest because the nylon tube was much too long for the arterial defect. In spite of acute angulation, it remained patent for six months, at which time the animal was killed (Fig. 1). An aortogram obtained one and one-half years after implantation of a graft (animal No. 7) showed good filling of the prosthesis, as well as the vessels below (Fig. 1). Although one small wrinkle was seen near the midportion of the graft, no significant compromise of the lumen was apparent.

In Situ Appearance.—In animals reexplored after 24 hours, the tissues of the retroperitoneal area were found loosely adherent to the nylon prostheses. There was a thin layer of clotting blood surrounding the graft, as would be expected during the early phases of healing. Separation of the aorta and plastic segment from the surrounding structures was easily effected. Six months after implantation, examination of the grafted segment revealed a healed wound of the posterior peritoneum. The intestine was free, showing no tendency toward adherence to the graft. The tissues surrounding the aorta and the grafted segment were firmly fixed to the psoas muscles. Pulsations were felt through the fibrous mass, but the lateral limits of the nylon

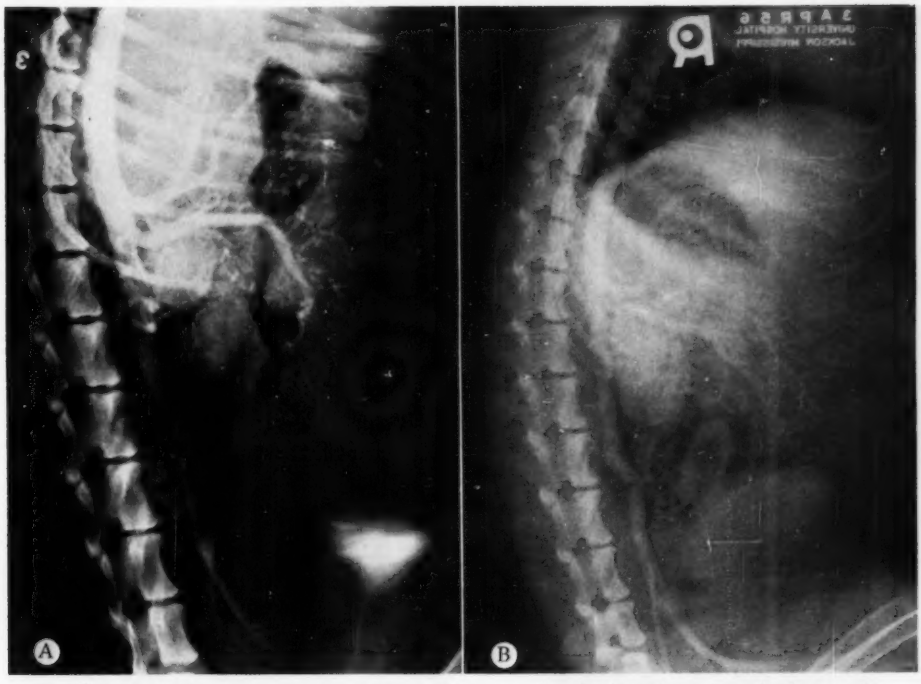


Fig. 1.—Aortograms. *A*, one and one-half years after implantation; *B*, redundant graft after six months.

were not discernible. The graft was separated from the surrounding structures with great difficulty. Considerable blood loss, in the form of a generalized ooze, was incited. The ureters, as well as the inferior vena cava, were firmly adherent to the sides of the graft. No pus was encountered. After one year the degree of reaction was not as intense as that found in the six-month specimen. The graft could not be seen under the posterior peritoneum, but the lateral limits were easily detected. Separation from the surrounding structures was accomplished with some difficulty. Exploration of the abdominal cavities of animals one and one-half and two years following insertion of a graft revealed a greatly changed situation. Retraction of the intestine revealed a smooth, normal-appearing posterior peritoneum. The aorta above and below the graft stood out boldly, as if no operative trauma had ever occurred in this area. The cloth prosthesis in its entirety was easily visualized through the posterior peritoneum. A cleavage plane between a fibrous sheath surrounding the grafts and the surrounding structures was easily developed, with loss of only a small amount of blood. There was no significant change in the caliber of the tube.

External Appearance.—The external appearance of the nylon tube removed 24 hours after insertion revealed a pink surface, which resulted from an accumulation of blood elements within the pores of the cloth. After six months the external surface of the grafted segment was completely surrounded by two layers of fibrous tissue. The outermost was thick, coarse, and loosely adherent, in contrast to the inner layer. The latter was glistening and translucent and had completely enveloped the fibers of the cloth. The specimens removed after one year were similar except for a decrease in the thickness of the outer fibrous layer. After one and one-half years the cloth was

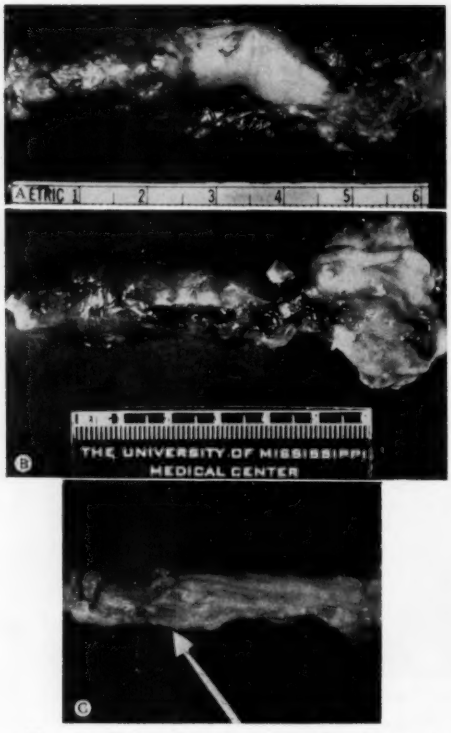


Fig. 2.—External appearance of nylon prostheses. *A*, six months; *B*, one year; *C*, one and one-half years.

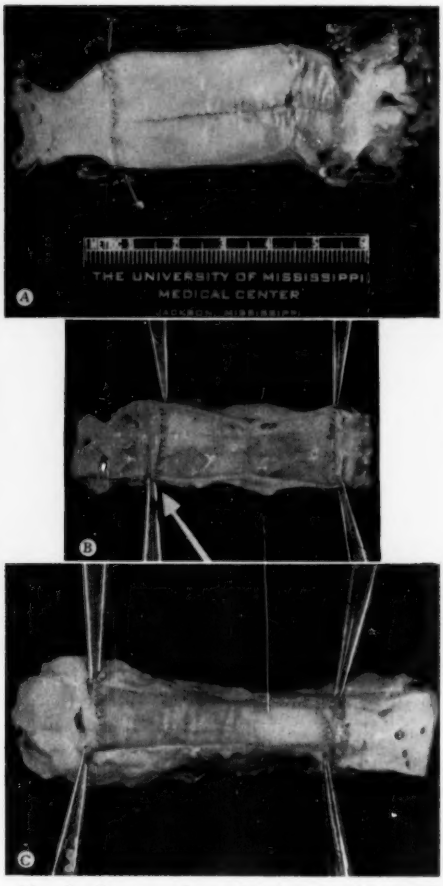


Fig. 3.—Inner surface of nylon prostheses. *A*, one year; *B*, one and one-half years; *C*, two years.

again found to be incorporated in a firm, fibrous inner sheath. On the posterior surface a loosely adherent outer fibrous sheath was also seen, while anteriorly this was replaced by peritoneum alone. The two-year specimen presented a similar appearance (Fig. 2).

Inner Surface.—The inner surface of the graft removed after 24 hours revealed only scattered deposits of fibrin. The animal that died 30 days after operation yielded a graft in which most of the inner surface was bare; however, a glistening, smooth lining had extended from the adjoining aorta to cover both suture lines. The remaining specimens, from six months through two years, were completely lined by a smooth layer of tissue, which grossly resembled endothelium. Close inspection of the 18-month specimen revealed two areas of ulceration of the endothelial lining. This was also seen in the 21-month specimen, and to a less pronounced degree in the 24-month specimen (Fig. 3). Microscopic examination of the six-month specimen clearly depicted the cellular characteristic of the lining cells. Considerable thickening of the inner layer was evident in older specimens.

Comment

Infection was apparently the cause of thrombosis in one animal. The reason for occlusion of the other two grafts was not apparent. The process must have been gradual because of the establishment of excellent collaterals, as evidenced by pal-

pable femoral pulses. Abdominal exploration during the first year of implantation revealed considerable retroperitoneal reaction. There was an extensive layer of granulation tissue surrounding the graft, with intimate adherence to the ureters and vena cava. The resolution of this process, after a two-year period, was very striking. The gastrointestinal tract remained free and mobile in all dogs, even in the animals in which the graft was filled with pus.

The outer surface of each graft was surrounded by two distinct layers of fibrous tissue. The outermost was coarse, red, and loosely adherent to the nylon. After two years the anterior portion of this layer had disappeared, so that the graft was glistening, white, and translucent. It was intimately adherent to the outer surface of the nylon, having thoroughly infiltrated the pores of the cloth. It is probable that this layer played a significant role in maintaining the strength of the graft wall.

The inner lining of the grafts extended from the aorta at each end. The one-month specimen showed the suture line to have been completely covered, while the six-month graft was lined throughout. A few small wrinkles were seen on the inner surface of all specimens but did not give rise to significant deleterious sequelae. It is of interest that the redundant graft, as seen in Animal 6, failed to become thrombosed. No complication could be ascribed to the inner seam, which was smoothly lined in a manner similar to the adjacent surfaces. In none of the specimens was there evidence of weakness of the graft wall, such as rupture or aneurysm formation. The inner surface of three specimens from one and one-half to two years after grafting revealed one to three areas of gross ulceration of the inner lining with exposure of the raw cloth. The exact significance of this finding is not clear at the present time. An extensive analysis of the histologic changes in this material will be the subject of a later report.

Summary

The implantation of nylon grafts into the abdominal aortas of 17 dogs was followed by thrombosis in 3 animals.

Palpable femoral pulses were not conclusive evidence of graft patency.

Changes in the constituents of the graft wall, as well as the surrounding tissue, over a two-year period are discussed.

In no instance was there rupture or aneurysm formation.

Areas of discontinuity of the endothelial-like lining of some of the older grafts are described.

Suite 313, Medical Arts Building
1151 N. State St.

REFERENCES

1. Barnett, W. O.: The Experimental Use of Nylon Tubes as Aortic Substitutes, Mississippi Doctor 34:117, 1956.

2. Blakemore, A. H., and Voorhees, A. B., Jr.: The Use of Tubes Constructed from Vinyon "N" in Bridging Arterial Defects—Experimental and Clinical, Ann. Surg. 140:324, 1954.

3. Claytor, H.; Birch, L.; Cardwell, E. S., and Zimmerman, S. L.: Suture-Line Rupture of a Nylon Aortic Bifurcation Graft into the Small Bowel, A. M. A. Arch. Surg. 73:947, 1956.

4. Deterling, R. A., Jr., and Bhonslay, S. B.: An Appraisal of Woven Synthetic Prostheses in the Vascular System, A. M. A. Arch. Surg. 72:76, 1956.

5. Egdahl, R. H.: Silicone Rubber as Aortic Grafting Material, A. M. A. Arch. Surg. 71:694, 1955.

6. Edwards, W. S., and Tapp, J. S.: Chemically Treated Nylon Tubes as Arterial Grafts, Surgery 38:61, 1955.

7. Girvin, G. W.; Wilhelm, M. C., and Merendino, K. A.: The Use of Teflon Fabrics as Arterial Grafts, Am. J. Surg. 92:240, 1956.

8. Harris, E. J.; Shumacker, H. B.; Siderys, H.; Moore, T. C., and Grice, P. E.: Pliable Plastic Aortic Grafts, A. M. A. Arch. Surg. 71: 449, 1955.

9. Harrison, J. H.: The Use of Teflon as a Blood Vessel Replacement in Experimental Animals, Surg. Gynec. & Obst. 104:81, 1957.

10. Hufnagel, C. A., and Rabil, P.: Replacement of Arterial Segments, Utilizing Flexible Orlon Prostheses, A. M. A. Arch. Surg. 70:105, 1955.

11. Julian, O. C.; Deterling, R. A., Jr., Su, H. H.; Dye, W. S., and Belio, M. L.: Dacron

Tube and Bifurcation Arterial Prostheses Produced to Specification, Surgery 41:50, 1957.

12. Kittle, C. F., and Taquechel, C.: A Preliminary Investigation of Dermal Heterografts (Leather) as Prostheses for Vascular Defects, A. M. A. Arch. Surg. 74:96, 1957.

13. Lary, B. G.; Meine, E. L., Jr., and de Takats, G.: The Experimental Use of Steel Mesh Tubes for the Replacement of Arterial Segments, A. M. A. Arch. Surg. 72:69, 1956.

14. Mortensen, J. D., and Grindlay, J. H.: Molded, Seamless Tubes of Polyvinyl Formalized Sponge, A. M. A. Arch. Surg. 72:871, 1956.

15. Ouzounian, G. S.: Arterial Grafting with Yard-Goods Nylon Cloth, A. M. A. Arch. Surg. 73:192, 1956.

16. Poth, E. J.; Johnson, J. K., and Childers, J. H.: The Use of Plastic Fabrics as Arterial Prostheses, Ann. Surg. 142:624, 1955.

17. Self, M. M.; Cooley, D. A.; DeBakey, M. D., and Creech, O.: The Use of Braided Nylon Tubes for Aortic Replacement, Ann. Surg. 142: 836, 1955.

18. Shumacker, in discussion on Julian et al.[11]

19. Shumacker, H. B., Jr.; Harris, E. J., and Siderys, H.: Pliable Plastic Tubes as Aortic Substitutes, Surgery 37:80, 1955.

20. Shumway, N. E.; Gliedman, M. L., and Lewis, F. J.: An Experimental Study of the Use of Polyvinyl Sponge for Aortic Grafts, Surg. Gynec. & Obst. 100:703, 1955.

21. Sanger, P. W.; Taylor, F. H.; Matsuba, T., and Salomone, F.: The Use of Artificial Fiber as an Artery Substitute, Ann. Surg. 143:862, 1956.

22. Szilagyi, D. E.; Shonnard, C. P.; Lopez y Lopez, J., and Smyth, N. P. D.: The Replacement of Long and Narrow Arterial Segments, Surgery 40:1043, 1956.

23. Voorhees, A. B.; Jaretzki, A., III, and Blakemore, A. H.: The Use of Tubes Constructed from Vinyon "N" Cloth in Bridging Arterial Defects, Ann. Surg. 135:332, 1952.

24. Wesolowski, S. A., and Sauvage, L. R.: Comparison of the Fate of Orlon Mesh Prosthetic Replacement of the Thoracic Aorta and Aortic Bifurcation, Ann. Surg. 143:65, 1956.

Congenital Bilobed Gallbladder

RAYMOND E. ANDERSON, M.D., and WELDON T. ROSS, M.D., McMinnville, Ore.

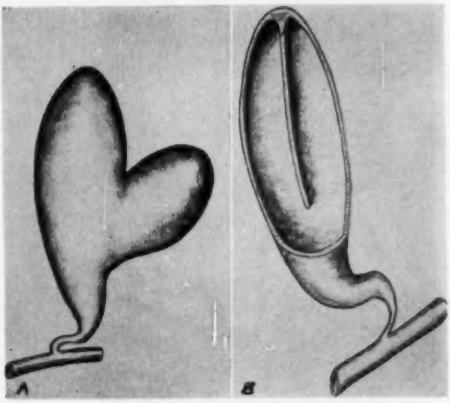


Fig. 1.—*A*, the cleft type of bilobed gallbladder; *B*, the septal division type of bilobed gallbladder.

The bilobed gallbladder, or vesica fellea divisa, is an extremely rare congenital anomaly in man. This malformation is represented by a structure having two separate fundic cavities, united at their bases and joined to the ductus choledochus by a single cystic duct. It is differentiated from the double, or accessory, gallbladder, called vesica fellea duplex, by the presence of independent cystic ducts, draining the individual fundic cavities of the latter type. Two distinct anatomical configurations of the bilobed gallbladder have been described. The first is that in which the body of the organ is completely or partially separated into two lobes by a deep cleft, resulting in a Y- or T-shaped viscus. The second form has a single fundus, divided into paired mucosal compartments by a longitudinal septum. In either instance the lobes may be of the same or unequal sizes (Fig. 1).

Eight proved cases of bilobed gallbladder have been reported in the literature [1-7] (Table 1), and reference has been made to eight other cases [8-14] in which the diagnosis has been questionable or the presence of the anomaly not substantiated by actual examination of the organ (Table 2). Of the eight cases of vesica fellea divisa, five have been of the cleft-lobe type, and three have been examples of the septal division.

The case herein discussed was found to have a bilobed organ containing a longitudinal fibrous septum and, therefore, represents, to the best of our knowledge, the fourth such anomaly of this type and the

Submitted for publication April 17, 1957.

From the Surgical Department, General Hospital.

TABLE 1.—*Proved Cases of Bilobed Gallbladder*

Case	Author	Year	Sex	Age	Signs or Symptoms	Pathological Findings	Type of Anomaly
1	Deaver and Ashhurst [1]	1914	F	55	None; patient died of apoplexy	Stone present in larger lobe: autopsy finding	Cleft
2	Rycroft [2]	1923	F	42	Biliary colic with jaundice for 13 yr.	Stone in one lobe; chronic cholecystitis: surgical finding	Septal
3	Meyer [3]	1926	F	55	Gallstone colic; fever and jaundice	Chronic cholecystitis; stones in each lobe: surgical finding	Cleft
4	Phillips, Isaac, and MacDonald [4]	1931	M	48	Recurrent colic with jaundice and pancreatitis	Chronic cholecystitis: surgical finding	Cleft
5	Phillips, Isaac, and MacDonald [4]	1931	F	56	Recurrent colic with jaundice for 2 yr.	Chronic cholecystitis: surgical finding	Septal
6	Hilt [5]	1937	F	37	Generalized abdominal pain; x-ray showed two bladders	Chronic cholecystitis: surgical finding	Cleft
7	Stolkind [6]	1940	M	53	None; patient died of glioma of brain	None; normal tissue: autopsy finding	Septal
8	Guyton [7]	1946	F	42	Acute pain; nausea and vomiting; x-ray—nonvisualization	Chronic cholecytitis and stones in both lobes: surgical finding	Cleft
9	Anderson and Ross	1957	F	54	Colic, nausea, food intolerance; pain	Chronic cholecystitis in both lobes: surgical finding	Septal

TABLE 2.—*Unsubstantiated Cases Referred to as Bilobed Gall Bladder*

Case	Author	Year	Disqualifying Factor
1	Cruveilhier[8]	1865	Drawing in textbook of two cystic ducts; no substantiated case report or reference to actual examination
2	Ullmann[9]	1926	X-ray diagnosis only; later thought to be a diverticulum, after surgical exploration
3	Esau[10]	1926	Hourglass type of gallbladder deformity
4	Stadnizky[11]	1936	Hourglass type of gallbladder deformity
5	Weiss[12]	1936	X-ray only; not confirmed by examination of organ
6	Galambos[13]	1953	X-ray only; not confirmed by examination of organ
7	Galambos[13]	1953	X-ray only; not confirmed by examination of organ
8	Corcoran[14]	1954	X-ray only; not confirmed by examination of organ

ninth proved example of vesica fellea divisa reported in the literature.

Report of a Case

The patient, a 54-year-old white woman, was first seen on Aug. 3, 1956, with a history of epigastric and right upper quadrant pain for several years. The pain was experienced after the ingestion of fatty or "heavy" foods. Despite the patient's efforts to avoid these foods, the distress had become severer during this period of time and had been especially pronounced for two months prior to her visit. The pain was described as a dull ache, radiating to the intrascapular area along the right costal margin, and was associated with nausea, belching, and a feeling of fullness and abdominal distention. Occasionally the pain would become colicky in nature, and precipitated a period of vomiting.

Except for an occasional episode of glycosuria, transient in nature, the patient gave no significant past history. She was occupied as a housewife, had been accustomed to good health all her life, and gave no other symptoms. Bowel and urinary functions were good; the patient had passed through a natural menopause seven or eight years previously, and her weight had remained stable at approximately 135 lb. Physical examination revealed a sparse, middle-aged woman, in no apparent distress at the time of the examination. The blood pressure was 140/80; pulse 72 a minute, regular and full. The chest was clear, heart tones normal, and head, neck, ears, nose, and throat without evidence of abnormality. The abdomen was scaphoid; no masses were felt, and the bowel sounds were normal. There was, however, some tenderness to deep palpation in the right upper quadrant, just under the costal margin. The liver was not palpable or tender. The reflexes were physiological, and the color and consistency of the skin were normal.

Fig. 2.—Oral cholecystogram showing the presence of two independent fundic chambers, divided by a longitudinal septum.

Blood sugar was 102 mg. per 100 cc.; urinalysis showed a specific gravity of 1.012 and pH 5.5. No RBC or WBC present. Urine was negative for albumin but gave a 2+ reaction for sugar. Hemoglobin was 13.4 gm. per 100 cc.; WBC count was 7900. Oral cholecystography was undertaken on Aug. 7, which revealed a functioning gallbladder, divided into two lobes by what appeared to be a septal partition. There were no stones visible on the x-ray (Fig. 2).

A low-fat diet was prescribed, and the patient was placed upon a regimen of antispasmodics and bile salts. Her symptoms continued, and on Aug. 31 an upper gastrointestinal x-ray series was done. This study failed to reveal any evidence of pathology. During the following six weeks she was seen on three occasions following episodes of right upper quadrant pain and nausea with vomiting, but, except for tenderness over the region of the gallbladder, the physical examination was negative at each of these visits. At no time did she experience fever or chills or give evidence of jaundice. On Oct. 12 intravenous cholecystography was carried out, which again revealed the presence of a double gallbladder, demonstrating a single cystic duct, but without evidence of cholelithiasis (Fig. 3).

Fig. 3.—Intravenous cholecystogram revealing the single cystic duct which drains both the fundic chambers.

In the three and one-half month interval following this last examination, the patient continued to suffer with severe indigestion, right upper quadrant pain, and nausea. Her life was becoming miserable because of the continuous distress and the inability to enjoy a normal diet. On Feb. 11, 1957, a barium enema x-ray study of the colon was undertaken, but this also was negative.

The patient was admitted to the General Hospital on Feb. 16, 1957. The physical examination at the time of this admission was unchanged from that of Aug. 3, 1956. RBC count 4,710,000, with 99% hemoglobin; WBC count 14,750, with 87% polymorphonuclear leukocytes; urinalysis completely negative; prothrombin activity 90%; blood urea nitrogen 13.0 mg. per 100 cc.; serological test for syphilis negative.

Surgery was carried out on Feb. 18. A right upper quadrant para-median incision was made and the abdomen entered with ease. Exploration of the abdominal viscera revealed no evidence of pathology other than in the gallbladder. A single fundus was observed, which was bound down to the surrounding tissue by adhesive bands. The porta hepatis was normal, and a single cystic duct joined the gallbladder to the latter structure. There was no evidence of associated malformation in the liver or biliary tree, and the cystic artery coursed in its commonest location, lateral and superior to the cystic duct. The wall of the gallbladder appeared to be thickened, but palpation failed to reveal any evidence of stones. The organ was removed without difficulty; the abdomen drained and closed, and the patient returned to her room in good condition.

Gross examination of the organ revealed it to be approximately 10 cm. in length and 4 cm. in its maximum diameter. The cystic duct was unusually long and measured 3.5 cm. to its junction with the corpus. The structure was carefully dissected immediately after its removal and was found to contain a longitudinal fibrous septum, which divided it into two lobes of slightly unequal size for about 90% of its length. Each compartment was completely lined by mucosa, which had the appearance of a chronic inflammatory reaction. The wall of the organ was thickened, and several cholesterol polyps, 2 mm. in size, were observed. There were no stones present (Fig. 4).

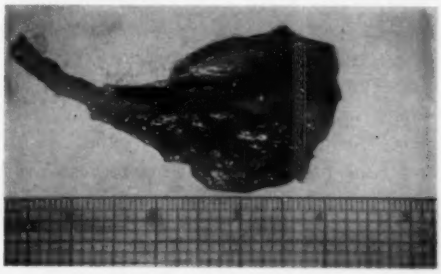
Microscopic diagnosis: Chronic cholecystitis.

The patient made an uneventful postoperative convalescence and was discharged from the hospital on the 10th postoperative day. Since the time of her surgery she has been without symptoms and has resumed a regular dietary regime. She is readapting herself to her family life with considerable satisfaction.

Comment

Congenital reduplication of the gallbladder among mammals other than man is not an infrequent occurrence. As far back as 31 B. C. reference is made by Pliny to its presence in an animal sacrificed by Augustus. Boyden,[15] studying over 10,000 specimens taken from domestic animals, found the incidence of double gallbladder to be 1 in 8 for cats, 1 in 28 for calves, 1

Fig. 4.—The gross specimen opened lengthwise, showing the longitudinal septum and the separate fundic chambers.



in 85 for sheep, and 1 in 298 for swine. By comparison, only 33 human cases had been reported in the literature to 1936, when Gross [16] presented a comprehensive survey to that date and added a case report of his own. During the ensuing 20-year period 30 additional cases have been observed, and in 1956 Flannery and Caster,[17] undertaking a summarization of these reports, concluded that the total number of recorded cases of double gallbladder amounted to 64. Both the bilobed and the accessory type of reduplications were included in these surveys.

In an effort to determine whether this curious anomaly was being observed in man more frequently than it was being reported in the literature, Boyden [15] laboriously obtained data from approximately 10,000 cholecystograms and 9,000 autopsy reports originating in several medical centers throughout the country. Five duplications were discovered, but each of these cases had been previously reported, and thus were included in the total number of known cases.

Embryology

At approximately the fourth week of fetal development the hepatic diverticulum appears on the ventral surface of the entodermal lining of the foregut.[18] A maze of branching and anastomosing cell cords grows out from the original structure, and the bud which is eventually to become the gallbladder originates at its base. This gallbladder anlage extends in a caudal and ventral direction as a solid growth of cells.[19] Subsequently, however, longitudinal division occurs, which splits the primitive organ into a partially divided structure as one stage of its eventual cavitation (Fig. 5). Incomplete resolution of the early solid stage or failure of fusion of the paired buds during this stage of embryonic growth, with the remaining elements represented by a septum or fold, may account for the presence in adult life of separate fundic cavities.

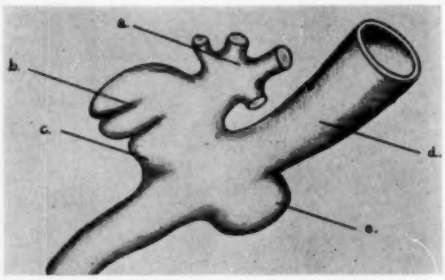


Fig. 5.—Diagrammatic representation of the embryonic foregut at approximately five weeks' gestation (5.5 mm.). (*a*) Primitive hepatic cells. (*b*) Gallbladder anlage, which is shown in a stage of longitudinal splitting. The failure of the lobes to reunite probably accounts for the presence of the bilobed adult structure. (*c*) Ventral pancreas; (*d*) stomach; (*e*) dorsal pancreas.

While it is generally accepted that certain types of congenital anomalies are frequently associated with multiple development defects, proof is lacking that this holds true for lesions of the gallbladder. Conflicting opinions have been registered on this point, reflecting the material available for study and recognizing the lack of accurate description of the associated anatomical structures. Flannery and Caster, for example, could find no mention of other biliary abnormalities associated with the 101 cases of anomalous gallbladders which they reviewed, and Gross lists 38 instances of absence of the gallbladder in which the liver and biliary tract were found to be normal. On the other hand, Gross mentions another series, of 35 cases of absence of the gallbladder, in which congenital atresia of the ducts was present, while Schachner [20] states that in 4 out of the 5 cases of double gallbladders to which he was able to find reference, other congenital maldevelopment was demonstrated.

Diagnosis

An appraisal of the information relating to the occurrence and symptomatology of gallbladder duplication tends to impress one with the clinical importance of the recognition and proper management of this anomaly. If discovered, the lesion demands considerable attention. The increased po-

tential for the development of disease is apparent, and serious efforts must be put forward to avert this possibility. If these fail or are impractical to the patient, the surgeon faces the task of removing tissue distorted by congenital malformation from an area in which the incidence of complication is still alarmingly high, even under the best of circumstances.

Cholecystography remains the most important means by which diseases of the gallbladder are diagnosed, and detection of congenital duplication is no exception. Climan [21] is credited with being the first to observe a double gallbladder by utilization of the Graham-Cole test. To 1948, diagnosis by x-rays had been made in 13 cases of double gallbladder,[22] and in the 20-year period prior to 1956, identification of 25 of the 31 reported cases was made by this means.

One is tempted to theorize that the presence of two fundic cavities draining into a single cystic duct is more likely to result in eventual disease than that which might occur in a normally formed organ. The high percentage of disease in the known cases of bilobed gallbladder probably substantiates this hypothesis. Moreover, among the 25 cases of double gallbladder which were reviewed by Flannery and Caster, indefinite symptoms of pain, intolerance to food, nausea or vomiting, and indigestion were present in 23. Nine of these patients underwent surgery, and evidence of cholecystitis was found in all these cases. The high incidence of inflammatory disease which appears to develop in a congenitally malformed gallbladder may be of some significance, but there is no evidence to support the premise that the presence of the anomaly itself, in the absence of disease, gives rise to symptoms referable to biliary dysfunction.

The patient herein reported was under our care and closely followed for nine months before surgery was undertaken. There was, perhaps, an overreluctance on our part to offer surgical therapy because of the known rarity of the lesion, but the continued disability of the patient made such a procedure mandatory. Subsequent to cholecystectomy, the patient has been symptom free and is now able to enjoy a normal way of life.

Summary and Conclusions

Duplication of the gallbladder is a rare congenital anomaly in man, although in the lower animals it is not an infrequent occurrence. The malformation may be the result of failure of refusion of the paired buds of the gallbladder primordium or the incomplete recavitation of the embryonic structure early in fetal life. Sixty-four previous cases of gallbladder duplication have been reported, eight of which have been of the bilobed or divided type, in which a single cystic duct merges into a structure with two distinct fundic chambers. The patient herein reported represents the ninth such case in man proved by autopsy or surgical examination. No definite symptoms can be attributed to the presence of the anomaly itself, although the incidence of inflammatory disease is probably higher in this deformity than that which occurs in the normally developed structure.

General Clinic and Hospital (Dr. Anderson).

REFERENCES

1. Deaver, J. B., and Ashhurst, A. P. C.: Surgery of the Upper Abdomen, Philadelphia, P. Blakiston's Son & Co., 1914, Vol. 2.

2. Rycroft, B. W.: Bilocular Gall-Bladder, J. Surg. 10:579-580 (April) 1923.

3. Meyer, A. W.: Doppelte Gallenblase, Deutsche Ztschr. Chir. 211:404-405, 1928.

4. Phillips, E. W. M. H.; Isaac, D., and MacDonald, J.: Four Biliary Anomalies: A Plea for Cholecyst-Gastrostomy, Brit. M. J. 1:665-666 (April 18) 1931.

5. Hilt, L. M.: Bilobed Gall-Bladder (Vesica Fellea Divisa), Radiology 28:233-234 (Feb.) 1937.

6. Stolkind, E.: Double Gall-Bladder: Report of a Case and Review of 38 Cases, Brit. J. Surg. 27:760-766 (April) 1940.

7. Guyton, W. L.: Double Gallbladder, Am. J. Surg. 72:118-120 (July) 1946.

8. Cruveilhier, E.: Anomalie de la vesicule biliare, Bull. Soc. anat. Paris 35:66, 1860.

9. Ullmann, H. J.: Personal Statement, Radiology 6:295-296 (April) 1926.

10. Esau, P.: Doppelbildung der Gallenblase durch entzündliche Vorgänge, Zentralbl. Chir. 53: 2971-2973, 1926.

11. Stadnizky: Trude Izhevsk med. Inst., 1936, Vol. 2.

12. Weiss, S.: Diseases of the Liver, Gall Bladder, Ducts and Pancreas, New York, Paul B. Hoeber, Inc., (Medical Book Department of Harper & Bros.) 1935.

13. Galambos, A.: Duodenojejunal Diverticulum with Double Gallbladder Observed in 2 Cases, Rev. Gastroenterol. 20:867-882 (Dec.) 1953.

14. Corcoran, D. B., and Wallace, K. K.: Congenital Anomalies of the Gallbladder, Am. Surgeon 20:709-725 (July) 1954.

15. Boyden, E. A.: The Accessory Gall-Bladder: An Embryological and Comparative Study of Aberrant Biliary Vesicles Occurring in Man and the Domestic Animals, Am. J. Anat. 38:177-233 (Nov.) 1926.

16. Gross, R. E.: Congenital Anomalies of the Gallbladder: A Review of 148 Cases, with a Report of a Double Gallbladder, Arch. Surg. 32: 131-162 (Jan.) 1936.

17. Flannery, M. G., and Caster, M. P.: Congenital Abnormalities of the Gallbladder: 101 Cases, Surg. Gynec. & Obst. 103:439-457 (Nov.) 1956.

18. Patten, B. M.: Human Embryology, Philadelphia, The Blakiston Company, 1946.

19. Arey, L. B.: Developmental Anatomy: A Textbook and Laboratory Manual of Embryology, Philadelphia, W. B. Saunders Company, 1946.

20. Schachner, A.: Anomalies of the Gallbladder and Bile Passages, with a Report of a Double Gallbladder and a Floating Gallbladder, Ann. Surg. 64:419-431 (Oct.) 1916.

21. Climan, M.: Duplication of the Gallbladder Demonstrated by Cholecystography, M. J. & Rec. 130:73-74 (July 17) 1929.

22. Verstandig, C. C., and Moore, D. B.: Double Gall Bladder Demonstrated by Oral Cholecystography, Connecticut M. J. 12:314-315 (April) 1948.

Surgical Management of Chronic Ulcerative Colitis

WILLIAM S. CARPENTER, M.D., and PAUL J. CONNOLLY, M.D., Detroit

During the 82 years since ulcerative colitis was originally described, little has been learned regarding its etiology. Medical treatment, combined on occasion with psychotherapy,[1] has been effective in controlling the disease in 50% to 80% of patients. In the others, some form of operative surgery has been necessary to eradicate the disease. During the past seven years we have had occasion to treat, surgically, 33 such patients. Our experience with this group, including the indications for operation and the results, form the basis for this article.

Ulcerative colitis may occur at any age, having been reported in the newborn[2] and the aged. In this series, the youngest patient operated on was 12 years of age and the oldest was 65. Sixty-one per cent of the patients were less than 40 years old at the time of operation. There were 14 men and 19 women in the group.

Indications for Surgery

The indications for surgery were the usual ones mentioned by others.[3] In many cases there was one major and several minor indications.

Acute Fulminating Disease.—About 5% of ulcerative colitis patients will be in this fulminating stage. The patient is critically ill, toxic, with a fever of 102-105 F, a rapid pulse, marked diarrhea, and often abdominal distention. In the presence of such fulminating disease, the mortality has been high in the first or subsequent attacks.

In fulminating disease, the utmost effort should be made to produce a remission by medical measures. In addition to general support, the most effective treatment is probably a 10- to 14-day course of cortisone.[4] The likelihood of the occurrence of a remission must be evaluated before the patient's condition has so deteriorated that the risk of operation is prohibitive. Medical measures are most likely to be effective during the first two or three weeks, after which time surgery had best be considered in the fulminating case. Prolonged delay, when corticotropin or cortisone is used, may be dangerous and the patient who has been on large doses of cortisone for many weeks during a fulminating attack may have a better chance to survive without surgery at such a time. In view of the high mortality associated with subsequent attacks of ulcerative colitis in patients who have had a fulminating attack,[5] such patients are advised to have elective colectomy during a stage of remission, if such occurs. There were five fulminating cases in our series, two of which had the added complication of massive hemorrhage. In two of the five cases, medical ileostomy had been used but failed to halt the fulminating course of the disease. In two others cortisone had been given, one for an extended period, without benefit. It is in these fulminating cases that the decision for operation is so difficult but delay so costly.

Recurrent and Continuous Disease.—The commonest reason for patients to be referred for operation was the failure of medical measures to control the diarrhea. These patients fall into two general groups. In one group are those in which the disease has the recurrent episodes that are characteristic of ulcerative colitis. There are flare-ups of symptoms for a few days or weeks, occasionally fulminating, followed by months, or even years, of apparently good

Submitted for publication June 21, 1957.

From the Surgical Service of Harper Hospital and Mount Carmel Mercy Hospital.

health. As time goes on, the periods of illness get longer and more frequent, and the patient cannot be considered medically controlled. In the group of continuous disease, the symptoms of diarrhea, cramps, anemia, and loss of weight, although not necessarily severe, are constant over weeks to several years. This chronic disease, with resultant near-invalidism, finally causes the patient to seek surgical help. In our group, there were 25 patients in whom recurrent or continuous symptoms directly of colitis made surgery necessary. They were about evenly divided between those with the recurrent and those with the continuous type. In many cases, of course, it was difficult to differentiate. Recurrent disease had been present for many years, and the present relapse had been continuous for many months. We have not found it necessary to urge operation in these cases. In most instances the patient is quite desperate in his search for help and accepts the operation willingly as the lesser of two problems.

Bleeding.—Massive bleeding was the indication for surgery in 4 of the 33 cases. In two patients it was the symptom that decided the urgent necessity for operation during a fulminating attack. It is doubtful whether either of these patients would have survived without operation.[6] In the other two patients there were no symptoms of colitis other than recurrent episodes of massive colon bleeding, necessitating hospitalization and transfusions. In both patients the transverse colon alone was involved. Operation was performed electively between episodes of bleeding.

Malignant Degeneration.—The risk of malignant degeneration in ulcerative colitis of long standing has been commented upon by many authors. It seems fairly well established that a patient who has had active ulcerative colitis for over 10 years has a 10% to 30% chance of developing carcinoma of the colon or rectum.[7,8] Such a carcinoma is difficult to diagnose early and is usually rapidly growing and frequently multiple.[9] The mortality rate in carcinoma of the colon, secondary to ulcerative colitis, has been reported to be as high as 93%.[3] Although eight of our patients had had ulcerative colitis for over 10 years, this fact alone was not the main indication for operation. Actually, in most cases of persistently active ulcerative colitis for this long a period, indications other than fear of carcinoma are quite clear.[10] There was one carcinoma in this series, a 24-year-old, 70 lb. man, who had been treated for active ulcerative colitis for 12 years. The first new symptom was fever and a left lower quadrant mass. At operation, a carcinoma of the sigmoid with diffuse abdominal carcinomatosis was found. He survived two weeks after ileostomy.

Perforation and Obstruction.—Perforation or obstruction of the colon may occur and necessitate operation. Neither was present in this group of patients. Ripstein has reported an 8.4% incidence of perforation in 142 cases of ulcerative colitis.[11] Several reports of perforation of the colon during steroid therapy for ulcerative colitis have been published.

Pseudopolyposis.—Pseudopolyposis has been suggested as an indication for operation, but its relationship to carcinoma has not been established. It is our opinion that pseudopolyposis represents the end-result of previous deep penetration of the colon. The likelihood of return to normal in such a colon seems quite remote. On this basis, operative intervention is indicated. Pseudopolyps, however, do not necessarily mean long-standing disease, having developed within a few months in some cases. Pseudopolyps were seen by x-ray or sigmoidoscopic examination in 13 of our cases (42%).

Other Indications.—Other symptoms or complications of ulcerative colitis may influence the decision in favor of surgery, although they may not be the primary indication. These include arthritis, skin lesions,[12] multiple fistulae and perianal sinuses, cirrhosis, and thrombophlebitis.

Many of our patients had one or more such contributing indications for operation.

We have become quite definite in our attitude when advising surgery in ulcerative colitis. Much of the hesitancy in physicians' advising, and patients' accepting, colectomy with ileostomy has been the lack of actual contact with the postcolectomy patient. We have been advised that it is sometimes better not to explain too much about an ileostomy because the patient may refuse to have the operation. We have found the opposite to be true. Except in an emergency, we insist that a patient not decide about the operation until he has had a chance to see and discuss the situation with at least one postcolectomy patient. This is worth much more than any description we might give him. With the postoperative status clearly in mind, he can then decide whether his symptoms are severe enough to justify his accepting operation. He is more likely to be satisfied with his own decision than one that is made for him.

In discussing colectomy, physicians and patients alike are now assisted by "Ileostomy Clubs."[13] Already formed in several cities, including Detroit, such clubs have the function of providing firsthand information about life with an ileostomy for the patient considering colectomy. The organization welcomes inquiries from physicians, and in Detroit the meetings of the group are open to anyone interested. The "QT" Club of Boston has published a "Manual for Ileostomy Patients," which is helpful to both the physician and the patient.

During the seven years in which we have operated upon these patients, the choice of surgical procedure has changed considerably. Originally we hoped that the colon would heal, or the symptoms be relieved, following ileostomy. However, none of the early patients, treated by ileostomy alone, were relieved for more than a few months, and now all have had colectomy and abdominoperineal resection. Cattell, in 1948, reported that he was able to close 10% of the ileostomies performed early.[14] More recent reports have shown ileostomy alone to be of little value[15] and emphasize the possibility of malignant degeneration in such a defunctionalized colon.[16] Ileostomy to induce remission in the fulminating case had been used for many years, and we initially tried it. Two fulminating cases were so treated, with one death resulting. The rationale of ileostomy and simultaneous colectomy for fulminating ulcerative colitis, as suggested by Crile[5] and Ripstein,[17] seemed more reasonable. Four of our cases have been so treated, with one death due to multiple small-bowel perforations, possibly related to prolonged cortisone administration and protein depletion. It is interesting to note that in 1950 Jones, at the Cleveland Clinic, advised that no patients be operated upon during the fulminating stage.[15] By 1951 the attitude had completely changed.[5]

When it became obvious that ileostomy alone was not worthwhile as treatment for ulcerative colitis, the elective cases were then treated by simultaneous ileostomy and colectomy, followed by abdominoperineal resection. Six patients were so treated, without mortality. The postoperative course was smooth, and the patients improved much more rapidly than after ileostomy alone. More recently we have adopted one-stage total proctocolectomy. The abdominoperineal resection adds little to the operative procedure and does not seem to add to the mortality or morbidity. The patient is relieved that only one operation is necessary. The hospital stay is considerably shortened, several such patients having been discharged 14 to 16 days after operation. The one-stage proctocolectomy has been done on the last 12 patients with diffuse ulcerative colitis, operated upon electively, without mortality.

Occasionally a patient will be seen in whom the disease appears to be segmental, with the rectum uninvolved. Two such patients were treated by colectomy and ileoproctostomy for massive bleeding from ulcerative colitis of the transverse colon. One has remained free of symptoms for five

years; the other has been operated on too recently to permit evaluation.

We have favored resection of the rectum as part of the surgical treatment for diffuse ulcerative colitis. This attitude, however, has not been universally accepted. If allowed to remain, the rectum may be the source of recurrent symptoms, even of a fulminating nature. More important, however, is the risk of development of carcinoma in this segment, which has been reported a number of times.[8,18-20] Knowing that the rectum is a common site of carcinoma, it seems unwise to remove all the colon except this segment. In favor of not removing the rectum is the possibility that this segment might heal and continuity be reestablished. This certainly rarely occurs in diffuse ulcerative colitis. The risk of producing impotence in young men has been mentioned. If the dissection is carried out very close to the rectal wall, other pelvic structures are not disturbed. The troublesome urinary retention seen in abdominoperineal resection for carcinoma has been noticeably absent. Careful questioning of patients has not revealed any complaint of impotence.[21]

Deaths

Of the 33 patients operated on, 3 are now dead. One was the man with abdominal carcinomatosis when first seen. The second was a postpartum, 21-year-old woman who was in a fulminating attack when an ileostomy alone was performed. She developed thrombosis of the aorta 11 days after operation. The third was a 22-year-old woman who had been in the fulminating toxic phase, with a temperature as high as 105 F for two months and had been treated by corticotropin and cortisone for four weeks before operation. In the 30 patients who had a colectomy there was one death, giving a mortality rate of 3.3%.

Complications

Of the patients who survived, the complications can be divided into those directly related to the operation and those involving the resultant ileostomy.

There were 11 patients in whom there was one or more complication directly related to the procedure. One patient developed a pelvic abscess following a one-stage proctocolectomy. She eventually recovered, but hospitalization was prolonged to six weeks. One patient had hemorrhage from the perineal wound, which necessitated reoperation. Recovery was uneventful. Two patients developed intestinal obstruction due to adhesions, necessitating reoperation. In one patient who had received steroids preoperatively, the distal end of the colon, which had been brought out through a left lower quadrant stab wound, retracted into the peritoneal cavity several days after operation and had to be retrieved surgically. Localized peritonitis developed, but the patient recovered. Urinary retention, necessitating an indwelling catheter for eight months, occurred in our first case of abdominoperineal resection for ulcerative colitis before we began to concentrate on resecting close to the bowel. The patient returned to work, wearing the catheter, two months after the operation. Recovery of function was eventually complete. One patient had a perineal abscess, necessitating drainage two months after operation. The perineal wound had been closed primarily with a drain, as has been our routine procedure. In one patient, now 17 years old, the perineal wound has failed to heal during the four and a half years since her operation. All efforts, including curetting the cavity and investigating the tissue and discharge for specific etiology, have failed to produce healing. The patient's course has otherwise been uneventful except for ileostomy revision. There were three major wound infections, as well as several minor ones. When we have done staged procedures, we have drained the incision left by excising the distal colostomy site. Some of these have drained purulent material. Two patients developed marked gastric dilatation, quite unexpectedly, late in the post-

operative course. Both were relieved by several days of intubation. One patient developed thrombophlebitis and pulmonary embolism, from which she recovered. One patient developed jaundice three months after colectomy, which subsided with medical measures. Three patients presented serious electrolyte problems. In two of these the imbalance followed colectomy for massive hemorrhage during a fulminating attack. The other was a patient who had received rather prolonged therapy with steroids preoperatively. All patients who have had colectomy and ileostomy must be handled carefully from the standpoint of electrolyte balance. A number of other patients had minor imbalances, which were easily corrected.

Some of our most troublesome problems have concerned the ileostomy. As many others have remarked, the occurrence of stenosis and prolapse is still frequent enough to be a source of concern in spite of improvement in the technique of ileostomy. We have tried various methods of making the ileostomy and have varied the length of the ileum above the skin level, but have been unable completely to overcome the difficulties. We believe the problem of prolapse is now minimized by suturing the cut edge of the ileal mesentery to the peritoneum, as suggested by Garlock[22] and Cattell.[23] We have taken an additional safeguard by suturing the mesentery along the edge of the bowel for 4 to 5 in. (10 to 12.5 cm.) to the parietal peritoneum. Lichenstein and Herzikoff have presented an unusual method which they found helpful in a difficult prolapse.[24]

Our major problem has been stenosis of the ileostomy, both early and late, in the postoperative period. With the danger of prolapse minimized, we make a large opening through all layers of the abdominal wall, but this has not completely solved the problem. We turn back either the full thickness of the ileum or the mucosa alone and suture it to the skin to maturate the ileostomy.[25,26] We feel that maturating the ileostomy has been a great improvement. It allows immediate application of the bag and prevents obstruction from edema, which we previously expected at the 10th to the 14th postoperative day. However, some ileostomy stomas have become stenosed months later. Since a stab wound is used for the ileostomy, a bag is cemented to the skin before the patient leaves the operating room. For this temporary bag we use the Davol, with the rubber flange especially made so that the opening can be cut to fit the ileostomy. For the permanent bag we use the Rutzen.

In spite of all precautions, our incidence of stenosis is still fairly high. Of 28 surviving ileostomy patients in this series, 17 have had no trouble at all with the ileostomy. One patient developed multiple furuncles about the ileostomy several months after operation. The other 10 patients developed stenosis requiring revision. Seven patients had a single revision, from two months to two and a half years after the original operation. One patient had two revisions, the first being 19 months after surgery and the second 2½ years later. One patient had five revisions; the first was two years after ileostomy, and the last was two and a half years later. One patient had a total of six revisions in a three-year period and has now been well for four years.

Collection of the ileal content and preservation of healthy skin about the ileostomy have been simplified by the commonly used adherent bags. We have hesitated to use a bag which does not cement to the skin. Substitution of commercial solvents for the ether or benzene previously used has made application of the bag more comfortable.

Results

In spite of the ileostomy problems, the end-results of total colectomy for ulcerative colitis have been most gratifying. It is probably because these patients are so miserable when they reach the surgeon that

they appreciate the return to good health in spite of having an ileostomy.

The physical results are the easiest to measure. Weight gain is practically universal. Some have almost doubled the preoperative weight. We have several women who worry about being overweight. All patients eat a regular diet. The anemia, which has often been present for years, is corrected.

The results from the social standpoint are just as gratifying. From a person who was restricted in his social activities by the proximity of a bathroom, as well as the limits of his physical ability due to malnutrition, the colectomy patient can return to normal activity. All of our survivors, except a mental case to be mentioned later, have returned to normal physical activities. Bowling, golf, dancing, swimming, horseback riding, and water skiing are a few of the sports they now enjoy. Two men have married since the operation, and several have fathered children. The 17-year-old girl wears an engagement ring. One patient had an uncomplicated delivery eight months after a one-stage proctocolectomy, having been unknowingly pregnant at the time of the operation.

The economic improvement is a real consideration in these cases. Practically all patients are in the same occupation as before surgery or have changed for reasons not related to the ileostomy. Their reliability now, as compared with frequent preoperative sick leaves, has allowed more advancement. The saving in medical costs, both professional and hospital, has been an important factor.

The improvement in the mental symptoms in many patients has been remarkable. One of our patients became worse mentally and is committed to an asylum. Others have changed from sullen, disagreeable persons to apparently well-adjusted people. This brings up the old problem as to whether the colitis patient has a nervous imbalance which is a causative factor in the disease, or whether the disagreeable symptoms of the disease cause nervous upsets. We have questioned some of our patients along this line, and the usual story is that a chronic diarrhea "makes you pretty disgusted and you care not what people think." The spouse and family are usually as appreciative as the patient himself. The home life has been changed from one which revolved around food restriction and diarrhea to a normal one. The ability to eat well is often a big factor.

Summary

From our experience in 33 cases of ulcerative colitis, we feel that there are some cases in which surgery is indicated. In the fulminating case the procedure of choice is colectomy to the low sigmoid with ileostomy. In elective cases with diffuse disease, the one-stage proctocolectomy is preferred. In segmental disease, a less extensive procedure may suffice.

The mortality and morbidity in one- or two-stage colectomy are low. The incidence of ileostomy dysfunction is our main problem. Postcolectomy patients are able to carry on normal physical and social activities.

1317 David Whitney Building (26).

REFERENCES

1. Groen, J., and Bastiaans, J.: Psychotherapy of Ulcerative Colitis, Gastroenterology 17:344-352 (March) 1951.

2. Beranbaum, S. L., and Waldron, R. J.: Chronic Ulcerative Colitis: Case Report in a Newborn Infant, Pediatrics 9:773-777 (June) 1952.

3. Lahey, F. H.: Indications for Surgical Intervention in Ulcerative Colitis, Ann. Surg. 133:726-742 (May) 1951.

4. Brown, G. M., and McAuley, J. S.: Cortisone Therapy in Ulcerative Colitis, J. A. M. A. 150: 1587-1591 (Dec. 20) 1952.

5. Crile, G. B., Jr., and Thomas, C. Y., Jr.: Treatment of Acute Toxic Ulcerative Colitis by Ileostomy and Simultaneous Colectomy, Gastroenterology 19:58-68 (Sept.) 1951.

6. Carpenter, W. S., and Connolly, P. J.: Emergency Colectomy for Massive Hemorrhage Complicating Acute Fulminating Ulcerative Colitis: Report of 2 Cases, Gastroenterology 32:137-141 (Jan.) 1957.

7. Lyons, A. S., and Garlock, J. H.: Relationship of Chronic Ulcerative Colitis to Carcinoma, Gastroenterology 18:170-178 (June) 1951.

8. Dennis, C., and Karlson, K. E.: Surgical Measures as Supplements to the Management of Idiopathic Ulcerative Colitis: Cancer, Cirrhosis and Arthritis as Frequent Complications, Surgery 32:892-912 (Nov.) 1952.

9. Shands, W. C.; Dockerty, M. B., and Bargen, J. A.: Adenocarcinoma of the Large Intestine Associated with Ulcerative Colitis: Clinical and Pathologic Features of 73 Cases, Surg. Gynec. & Obst. 94:302-310 (March) 1952.

10. Kiefer, E. D.; Eytinge, E. J., and Johnson, A. C.: Malignant Degeneration in Chronic Ulcerative Colitis, Gastroenterology 19:51-57 (Sept.) 1951.

11. Ripstein, C. B.: Perforation of the Colon in Ulcerative Colitis, Ann. Surg. 140:872-874 (Dec.) 1954.

12. Samitz, M. H., and Greenberg, M. S.: Skin Lesions in Association with Ulcerative Colitis, Gastroenterology 19:476-479 (Nov.) 1951.

13. Lyons, A. S., and Garlock, J. H.: Complications of Ileostomy, Surgery 36:784-789 (Oct.) 1954.

14. Cattell, R. B.: Surgical Treatment of Ulcerative Colitis, Gastroenterology 10:63-66 (Jan.) 1948.

15. Brown, C. H.; Gleckler, W. J., and Jones, T. E.: Surgical Treatment of Chronic Nonspecific Ulcerative Colitis: Results in 106 Cases, Gastroenterology 14:465-478 (April) 1950.

16. Gleckler, W. J., and Brown, C. H.: Carcinoma of the Colon Complicating Chronic Ulcerative Colitis, Gastroenterology 14:455-464 (April) 1950.

17. Miller, G. G.; Ripstein, C. B., and Tabah, E. J.: Surgical Management of Ulcerative Colitis, Surg. Gynec. & Obst. 88:351-358 (March) 1949.

18. Ripstein, C. B.; Miller, G. G., and Gardner C. McG.: Results of Surgical Treatment of Ulcerative Colitis, Ann. Surg. 135:14-21 (Jan.) 1952.

19. Bacon, H. E., and Trimpi, H. D.: Selection of an Operative Procedure for Patients with Medically Intractable Ulcerative Colitis, Surg. Gynec. & Obst. 91:409-420 (Oct.) 1950.

20. Wheelock, F. C., Jr., and Warren, R.: Ulcerative Colitis, New England J. Med. 252:421-25 (March 17) 1955.

21. Dennis, C., and Karlson, K. E.: Minimization of Risk and Disability in Idiopathic Ulcerative Colitis, Am. J. Surg. 90:761-766 (Nov.) 1955.

22. Garlock, J. H.: Surgical Treatment of Intractable Ulcerative Colitis, Ann. Surg. 113:2-14 (Jan.) 1941.

23. Cattell, R. B.: A New Type of Ileostomy for Chronic Ulcerative Colitis, S. Clin. North America 19:629-635 (June) 1939.

24. Lichtenstein, I. L., and Herzikoff, S. S.: Recurrent Ileostomy Prolapse—an Old Problem, Ann. Surg. 141:95-97 (Jan.) 1955.

25. Crile, G. B., and Turnbull, R. B., Jr.: Mechanism and Prevention of Ileostomy Dysfunction, Ann. Surg. 140:459-466 (Oct.) 1954.

26. Brooke, B. N.: Ulcerative Colitis and Its Surgical Treatment, Edinburgh, E. & S. Livingstone, Ltd., 1954.

Complete Homotransplantation of Canine Heart and Lungs

GUMERSINDO BLANCO, M.D.; ALBERTO ADAM, M.D.; DAVID RODRIGUEZ-PEREZ, M.D., and AGUSTIN FERNANDEZ, B.S., San Juan, Puerto Rico

Homotransplantation of a number of tissues (blood, skin) and organs (kidney) has received considerable attention for many years. Although, at present, successful transfer of most highly specialized tissues and/or organs is limited to that performed between pairs of identical twins, much interesting information has been gleaned in the laboratory and much useful, though temporary, clinical benefit has been obtained through its employment.

Failure of permanent "take" of homotransplanted tissue is due to rejection by the recipient animal after variable periods of time. This reaction is now believed to be immunological in nature.[1,2]

Quite independent of this immunological stumbling block are the technical difficulties inherent in transplanting some of the viscera. We have been stimulated by the challenge of these difficulties in relation to complete transplantation of the heart.

Most defects and lesions of the heart have been recently placed within the reach of surgical correction. A number of relatively frequent clinical conditions remain in which the extent of the congenital anomaly or myocardial damage associated with it or with an acquired valvular defect is such as to render the patient incurable even by the newer surgical techniques. Nothing short of removal and replacement of the diseased organ will be compatible with a return to health. It is pertinent, therefore, to explore technical maneuvers whereby such a transplant might be performed. Should the immunological deterrent to homotransplantation be eliminated in the future, such a procedure might become clinically applicable.

This communication reports on preliminary investigations in the above regard. The term complete is employed to denote the fact that the heart (and, in our experiments, the lungs, too) are transplanted to their normal site in the thoracic cavity and are expected to perform their normal functions, in contrast to other reported experiences of transplantation to ectopic sites, such as the neck.

Historical Survey

With but one reported exception, previous transplantations of the heart from one animal to another member of the same species have been carried out to extrathoracic sites. The first record of such an attempt was published by Mann, Priestley, Markowitz, and Yater[3] in 1933. These workers concerned themselves with transplantation of the canine heart from a donor to the neck of a recipient animal. The transplanted organ did not perform appreciable work in its new environment, yet beat regularly for periods varying from one to eight days. Studies performed under the above circumstances revealed that such a heart responded to hormonal (epinephrine, thyroxin), but not to nervous, stimulation. Similar experiences have been reported by later workers in this field.

Twenty years later Marcus, Wong, and Luisada,[4] and, independently, Downie[5] re-

Submitted for publication May 20, 1957.

From the Department of Surgery and the Experimental Surgery Laboratory, University of Puerto Rico School of Medicine.

Present addresses: Bailey Thoracic Clinic, Philadelphia (Dr. Blanco); Walker Thoracic Clinic, Charleston, W. Va. (Dr. Adam).

ported on survivals of from two to nine days in similar preparations.

Also in 1953 Neptune, Cookson, and Bailey [6] succeeded in preparing three complete homologous transplants in dogs in which the transplanted heart sustained the circulation for periods up to six hours. For technical reasons (reduction in number and complexity of anastomoses) the lungs were transplanted concomitantly. Hypothermia was employed to lower the metabolic needs of the transplanted heart and lungs, and of the recipient animal during the actual transfer.

Our approach to the problem has been technically similar to that employed by this last group of workers. To allow the heart to survive during the period of coronary "cut-off," while it is being transplanted, we have used elective cardiac arrest, utilizing the technique described by Melrose,[7] and applied clinically by Effler and co-workers.[8] The systemic circulation of the recipient animal is maintained by a pump-oxygenator during this same period.

Method

Two adult mongrel dogs of approximately the same size and weight were anesthetized with intravenous pentobarbital (Nembutal) sodium (30 mg/kg.), intubated, and attached to mechanical respirators. Thoracotomy was performed in both, using an incision through the left third and right sixth interspaces and across the sternum. This gave ample exposure to the intrathoracic contents. From here on, the procedures in the two dogs differed, and will be described separately.

In Dog 1 (recipient) plastic oxygen catheters, No. 14 F. in size, were inserted into the right femoral and external jugular veins and the right carotid artery preparatory to connecting this animal to a pump-oxygenator. Through the aforemen-

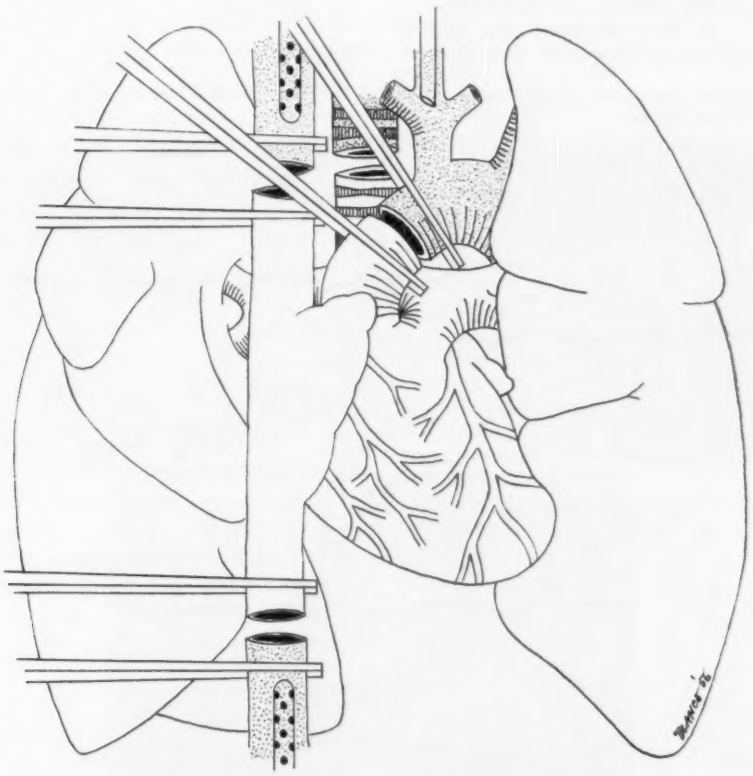


Fig. 1.—Complete homotransplantation of canine heart and lungs.

tioned thoracotomy the heart and lungs were mobilized as completely as possible so that they might be removed rapidly. The phrenic nerves were carefully preserved. Just before the transplant was to be effected, the venae cavae were occluded and the animal attached to the extracorporeal circuit (pump-oxygenator) for maintenance of its systemic circulation.

While these preparations were under way, another surgical team was mobilizing the heart and lungs of Dog 2 (donor). When this was complete, 2 cc. of a 25% solution of potassium citrate was diluted with 20 cc. of blood, and, after occlusion of the venae cavae with appropriate vascular clamps, the aorta was cross clamped about 3 cm. above its origin and the potassium citrate and blood were injected into its proximal segment. Heart action was arrested in this fashion. The heart and lungs were then excised by division of the venae cavae and aorta between Potts clamps and by section of the trachea.

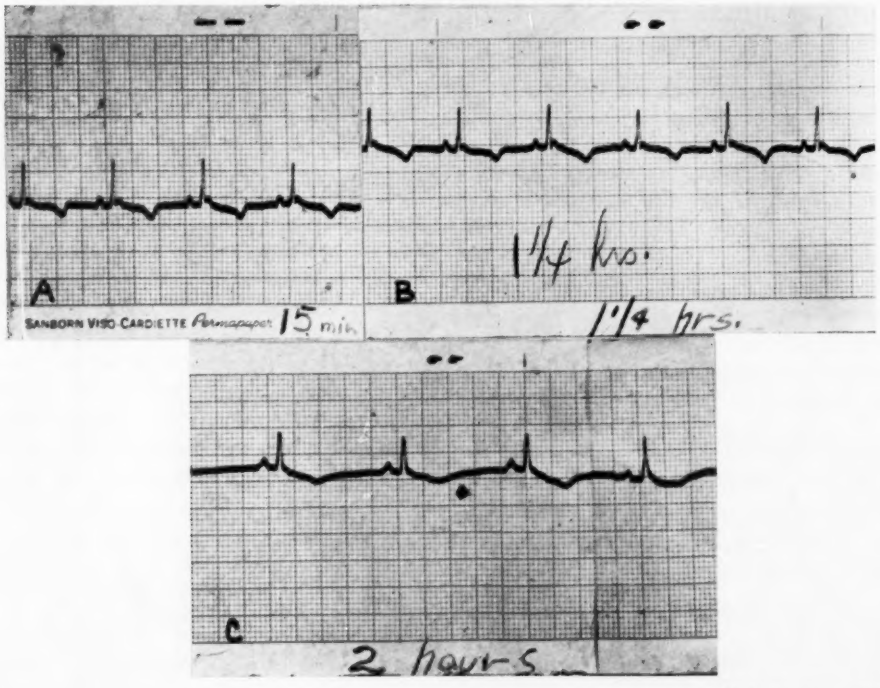
The excised organs (Fig. 1) were then transferred to the recipient, in which a similar excision had been carried out, and the viscera were placed in their normal anatomical relation, after which the proper vascular and tracheal anastomoses were performed. The aortic anastomosis was the first to be completed, and immediately thereafter the cross clamps were taken off the aorta, thus incorporating the heart and lungs in the systemic perfusion system maintained by the pump-oxygenator.

Shortly after the arterialized blood started perfusing the coronary vessels, auricular and ventricular contractions would appear, become coordinated, and gather strength, so that by the time the caval and tracheal anastomoses were finished, it was possible to reinflate the lungs and reattach the mechanical respirator, after which the pump was stopped. The tracheal anastomosis was wrapped in pericardium to make it airtight, and, after sucking the pleural cavities dry, the chest was closed.

Results

Eight transplants were attempted. Two of these were terminated during the procedure because of technical difficulties or mistakes. In the remaining six recipients, cardiac contractions became established in the transplanted heart and appeared to support the systemic circulation adequately for periods of one-half to four and one-half

Fig. 2.—Electrocardiographic tracings: *A*, 15 minutes; *B*, 1¼ hours, and *C*, 2 hours, after transplantation.



hours. In two dogs spontaneous respirations appeared after the mechanical respirator was disconnected, and in both corneal reflexes were active at this time. Survivals after transplantation averaged two and one-half hours, and death appeared to follow a variable period of weakened cardiac contractions, followed, in most animals, by ventricular fibrillation. In one such case the disappearance of forceful beats was reversed temporarily by a small (250 cc.) blood transfusion, suggesting that blood loss or pooling may have brought about the fatal outcome. In other animals we observed absence of corneal reflexes at the conclusion of the operative procedure, and death may be attributed to cerebral anoxia secondary to a prolongation of operative maneuvers beyond the safe period allowed by our particular extracorporeal circulation system. In two dogs the transplantation and anastomotic procedures lasted for more than one hour.

Electrocardiographic tracings taken with the transplants in situ indicate a regular sinus rhythm with well-formed auricular and ventricular complexes (Fig. 2). In many records one observes depression of S-T segments and inversion of T-waves in several of the standard leads.

Comment

Our experience with this method of complete homotransplantation of the canine heart and lungs has been encouraging with regard to the technical aspects of the procedure and the reliability with which cardiac action returns after the period of elective potassium arrest. Failure to obtain longer survivals may be related to a number of factors, including the maintenance of extracorporeal circulation for relatively long periods of time, lack of adequate blood replacement, etc. We feel at this time that potassium arrest provides a convenient method of maintaining very low metabolic requirements in the myocardium, and thereby allowing the time needed to perform the necessary anastomotic maneuvers. Final success with these preparations will depend on refinements of technique.

Summary

A method is described whereby it is technically feasible to transplant the canine heart and lungs from a donor animal to the thoracic cavity of a recipient. The transplanted viscera assume their functions for periods of time up to four and one-half hours after transplantation. Our initial experiences with this procedure are described.

708 Wolcott Dr., Chestnut Hill, Philadelphia (Dr. Blanco).

REFERENCES

1. Medawar, P. B.: Immunity to Homologous Grafted Skin: Suppression of Cell Division in Grafts Transplanted to Immunized Animals, Brit. J. Exper. Path. 27:9, 1946.

2. Dempster, W. J.: Observations on the Behaviour of the Transplanted Kidney in Dogs, Ann. Roy. Coll. Surgeons England 7:275, 1950.

3. Mann, F. C.; Priestley, J. T.; Markowitz, J., and Yater, W. M.: Transplantation of the Intact Mammalian Heart, Arch. Surg. 26:219, 1933.

4. Marcus, E.; Wong, S. N. T., and Luisada, A. A.: Homologous Heart Grafts: I. Technique of Interim Parabiotic Perfusion; II. Transplantation of the Heart in Dogs, A. M. A. Arch. Surg. 66: 179, 1953.

5. Downie, H. G.: Homotransplantation of the Dog Heart, A. M. A. Arch. Surg. 66:624, 1953.

6. Neptune, W. B.; Cookson, B. A.; Bailey, C. P.; Appler, R., and Rajkowski, F.: Complete Homologous Heart Transplantation, A. M. A. Arch. Surg. 66:174, 1953.

7. Melrose, D. G.; Dreyer, B.; Bentall, H. H., and Baker, J. B. F.: Elective Cardiac Arrest, Lancet 2:21, 1955.

8. Effler, D. B.; Groves, L. K.; Sones, M. F., and Kolff, W. J.: Elective Cardiac Arrest in Open-Heart Surgery, Cleveland Clin. Quart. 23:105, 1956.

Tendon Transfer for Old Radial Nerve Paralysis

HAROLD R. BRODMAN, M.D., New York

There have been many reports in the medical literature of the successful treatment of radial nerve palsy by tendon transplantation. The history of these operations since Drobñik's description,[4] in 1896, has also been reviewed. The work of Sir Robert Jones,[6] in 1916, crystallized the thinking on this subject and has been the basis of subsequent surgery. Many reports followed, chronicling the successful treatment of radial nerve palsy with various modifications of the Jones technique. The largest series of cases were accumulated in the experience of military surgeons during the great world wars. Experience in civilian practice is limited to the occasional cases.

The purpose of this paper is to report the successful treatment of a case of radial nerve palsy coming to surgery 24 years after nerve injury. In our patient we were concerned with the limiting factors in tendon transfer many years after the destruction of the radial nerve and the consequent paralysis and atrophy of the extensor muscles of the hand and wrist. Young and Lowe[10] reported 28 cases of radial nerve paralysis, with a lapse of time between injury and surgery of 2 months to 23 years. In the latter case they reported good results with tendon transplantation. In general, they found no correlation between their results and the duration of paralysis. Byrne,[3] in 1916, reported attaching the flexor carpi radialis to the extensors of the thumb and fingers. The tendon transfer in this case was performed two years after destruction of the radial nerve, and the result was "good." Scuderi[8] reported 45 cases from World War II. All but one of his tendon-transplant operations were successful. This unsuccessful case is of interest. Six months following the first operation a second procedure for tendon transfer was attempted. At the second operation such marked fibrosis had resulted in the fingers that the case was ultimately closed as a failure.

Submitted for publication June 12, 1957.
From the Bronx Hospital.

Report of a Case

The patient, a 32-year-old Negro, was first seen by me on Aug. 14, 1953. His complaints were referable to a radial nerve palsy sustained in an automobile accident 24 years previously, at the age of 8 years. At that time, the injury was on the medial posterior aspect of the right arm. The patient could not extend the wrist and fingers.

Physical Examination.—The patient was a well-developed, muscular man whose only positive physical findings were limited to the right upper extremity. There were multiple 4- to 6-in.-long, oblique, irregular, grooved, longitudinal scars on the medial posterior aspect of the right arm. The triceps muscle and the entire extensor apparatus of the right forearm were atrophied. The brachioradialis, extensor carpi radialis longus and brevis muscle bundle was atrophic. The right forearm measured 8¾ in. in diameter; the left, 10 in. The right midarm was 10 and the left 11½ in. in diameter. He could not extend the wrist and the proximal phalanges of the fingers or the thumb; nor was he able to abduct the thumb. Extension at the elbow against gravity was present. There was minimal hypesthesia in the region of the first dorsal web space. Passive motion of the joints was unrestricted. The hand, wrist, and fingers were held in a position of extreme flexion. The thumb was cupped in the hollow of the flexed fingers. The flexor musculature of the wrist and fingers was active and strong. The palmaris longus tendon was palpable.

Radiographic examination of the wrist and forearm was negative. The patient had positive Wassermann reactions of the blood and spinal fluid.

Operation.—On Aug. 24, 1953, the operation of multiple tendon transplantation, according to the technique of Billington for radial nerve palsy, was performed. Intravenous thiopental (Pentothal) anesthesia was employed, and use was made of the

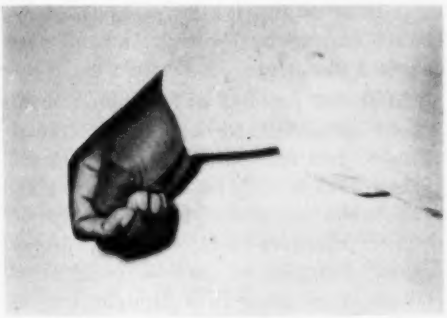


Fig. 1.—Preoperative position of hand.

pneumatic tourniquet with interval release of pressure.

Three incisions were made, as follows: First, a 2 in. longitudinal incision was made over the midportion of the radius at the level of the insertion of the pronator teres muscle; second, a 1 in. longitudinal incision was formed over the flexor carpi radialis tendon 3 in. proximal to the wrist joint; third, a skin flap was raised on the dorsum of the forearm by an incision starting 4 in. proximal to the pisiform bone on the ulnar border of the forearm and extending distally to the pisiform bone and then across the dorsum of the wrist at right angles to the base of the first metacarpal. In the first incision, the most distal expanse of the tendon of the pronator teres and the tendons of the extensor carpi radialis longus and extensor carpi brevis were isolated. In the second incision, the tendon of the flexor carpi radialis was isolated. In the third incision, the tendons of the extensor digiti quinti proprius, extensor digitorum communis, extensor indicis proprius, and flexor carpi ulnaris were identified. The tendons of the abductor pollicus longus and extensor pollicis brevis and extensor pollicis longus were also identified in this incision. The extensor tendons showed a marked degree of gelatinous degeneration.

Transfer of the flexor tendons to the extensor tendons was accomplished by using a buttonhole technique and suturing the tendons with interrupted 000 silk sutures under slight, but equal, tension with the wrist and fingers hyperextended. In the first incision the pronator tendon was released from its insertion and attached distally to the tendons of the radial extensors. The radial and ulnar flexors of the wrist were now released at their insertions through the third incision. The flexor carpi radialis was withdrawn through the second incision and tunneled obliquely to the dorsum of the wrist, where it was obliquely buttonholed through the long abductor and extensors of the thumb. Here it was sutured. The flexor carpi ulnaris was cleaned of muscle fibers for its distal 3 in. and was sutured similarly in an oblique manner to the extensors of the fingers. A flap of deep fascia was raised and turned over the tendinous expanse of the flexor carpi ulnaris and sutured in place. The deep fascia was closed with interrupted 000 plain absorbable surgical (gut) sutures and the skin closed with interrupted fine silk sutures. A compression dressing was applied. The wrist and fingers were fixed in midextension and the thumb in midabduction and extension, and the elbow was maintained at 90-degrees flexion.

Postoperative Course.—Postoperatively, there was slight edema of the dorsum of the wrist. Two weeks after surgery, the dressing was changed; all sutures were removed, and a new splint was applied. One week later the splint was removed and passive and active motion allowed. Three months following surgery the patient had achieved what appeared to be maximum range of motion of the right arm and hand. He found occupation as a truck driver. On March 16, 1957, almost four years later, he was reexamined. He was completely satisfied with the results, found his right hand entirely useful, and did not notice any limitation of function. Compared with the other hand, there was less strength. Examination revealed full pronation and supination of the right forearm. There was no active lateral wrist movement. Flexion power of fingers and wrist was grossly equal bilaterally. Extension on the right side was forceful but weaker than on the

Fig. 2.—Photomontage, illustrating postoperative range of motion of wrist and hand.

Fig. 3.—Postoperative picture demonstrating pinch and trapeziometacarpal arch. Part of the original wound in the arm is seen.

left. Opposition of the thumb to the individual digits was of such strength that it was impossible to extract a heavy piece of paper from the pinch grasp. There was minimal loss of the trapeziometacarpal arch. There was full range of motion of the thumb operated on. The patient stated that in his own experimentation he could find no difference between the side of operation and the normal side. There was full and equal flexion of the wrist with complete finger extension. There was 5 degrees less extension of the wrist on the affected side, with full flexion of the fingers. However, with complete extension of the fingers, extension of the wrist could be executed only to 180 degrees. This was the only major defect of range of motion. With the fingers completely flexed there was more wrist flexion possible on the side of operation than on the normal side. The wrist was stable. The total result was excellent from an objective and a subjective point of view.

Comment

The first problem in the management of this case was the question of adequate mobility of the joints of a hand that had been held in flexion for 24 years. We were satisfied at preoperative examination to find this mobility adequately present. The preoperative position of the digits was somewhat unusual for a radial nerve injury. The fingers and wrist were held in extreme flexion; the thumb was adducted and flexed beneath the fingers, owing to a well-developed and active flexor apparatus. This may, in effect have served to our advantage in that the flexor muscles to be used for transplantation were of good quality and tonus in spite of the absence of the antagonists. Prior to surgery, this patient used his flexor apparatus by hooking his hand over an object and gripping it firmly.

The second problem was the question of choice of procedure. Review of the literature led us to feel that minor variations in the Jones technique all led to equally good results when executed with proper attention to basic principles—i. e., suture at proper tension; direction of pull of transferred tendons in as close to a straight line as possible, providing a tendon bed through which the tendon could glide; suturing the tendon proximal to the carpal tunnel to allow for finger flexion [2]; retaining one wrist flexor,[11] and meticulous care with technique. We selected the Billington method [1] because of the proximity of the tendons to be transferred to the site of intended anastomosis and the presence of the palmaris longus to maintain wrist flexion. This tendon is absent in 12.6% of limb.[7] In cases in which this tendon is not palpable procedural modifications must be made. Neither arthrodesis nor tenodesis was used, in order to have a dynamic wrist and hand apparatus. Herbig and Witt feel that in long-standing cases of paralysis with frank muscular atrophy, Perthes' procedure is the only one of value. Perthes' operation [9] includes tenodesis of the extensor carpi radialis brevis and extensor carpi radialis longus to the radius and fixation of the extensor carpi ulnaris to the ulna, in addition to tendon transfer. To achieve stabilization of the wrist, to retain ability to flex, and to accomplish wrist extension, the pronator teres was sutured to the extensores carpi radialis longus and brevis in our case. In the late follow-up, the omission of tenodesis was found to be justified by the absence of overstretch of the transferred muscles and the consequent return of the wrist flexion.

Third, and most challenging, was the problem that occurred at the time of surgery. When the extensor muscles and tendons were exposed, the muscles, as expected, were fibrotic; the tendons, not as anticipated, were almost translucent, having

undergone gelatinous degeneration. The normal tough, fibrous appearance and character of the tendons was absent. Because of this, there was some hesitancy in continuing the procedure. However, depending on action to reestablish functional anatomy, we proceeded. In the postoperative period, firm, tough extensor tendons were palpable subcutaneously distal to the point of anastomosis to active muscles.

Summary

The history of tendon transfer for radial nerve palsy is alluded to with specific reference to experience in which a long delay occurred between injury to the nerve and attempt at tendon transfer. A case of radial nerve palsy occurring 24 years prior to treatment by multiple tendon transplants with excellent results is reported. Some of the problems in the handling of a case of this type are discussed.

2021 Grand Concourse (53).

REFERENCES

1. Billington, R. W.: Tendon Transplantation for Musculospiral (Radial) Nerve Injury, J. Bone & Joint Surg. 20:538, 1922.

2. Bunnell, S.: Surgery of the Hand, Philadelphia, J. B. Lippincott Company, 1956.

3. Byrne, P. J.: Murphy's Operation or Transplantation of the Flexor Carpi Radialis into the Extensors of the Thumb and Fingers in a Case of Musculo-Spiral Paralysis, Practitioner 96:642, 1916.

4. Drobñik, T.: Über die Behandlung der Kinderlähmungen mit Hilfe der Functionstheilung und Functionsübertragung der Muskeln, Deutsche Ztschr. Chir. 43:473, 1896.

5. Herbig, H.: Beobachtungen und Erfahrungen bei Sehnenplastiken zur Verbesserung der Funktion der Fallhand, Chirurg 19:171, 1948.

6. Jones, R.: On Suture of Nerves, and Alternative Methods of Treatment by Transplantation of Tendon, Brit. M. J. 1:679, 1916.

7. Morris, H.: Morris' Human Anatomy, edited by J. P. Schaeffer, Philadelphia, The Blakiston Company, 1942.

8. Scuderi, C.: Tendon Transplants for Irreparable Radial Nerve Paralysis, Surg. Gynec. & Obst. 88:643, 1949.

9. Witt, A. N.: Der funktionelle Ersatz bei der irreparablen Radialislähmung, Chirurg 19:167, 1948.

10. Young, H. H., and Lowe, G. H., Jr.: Tendon Transfer Operation for Irreparable Paralysis of the Radial Nerve, Surg. Gynec. & Obst. 84:1100, 1947.

11. Zachary, R. B.: Tendon Transplantation for Radial Paralysis, Brit. J. Surg. 33:358, 1946.

Complications of Aortography

JAMES E. ANTHONY Jr., M.D., Chicago

Since the introduction of aortography by dos Santos, Lamas, and Caldas,[1] in 1929, many thousands of aortograms have been made, with a low incidence of complications. The method has proved to be a valuable diagnostic means for the urologist, the cardiovascular surgeon, and the obstetrician. There were no fatalities among dos Santos' original 300 cases, and Smith et al.,[2] Evans,[3] and Felson [4] have each reported over 1000 cases, without fatality or serious complications. Despite this apparent safety, the procedure has not, at least until recently, gained widespread acceptance. Part of this reluctance may be based on the natural hesitancy of surgeons to puncture the aorta blindly, but undoubtedly the report of Henline and Moore,[5] in 1936, discouraged many clinicians. These investigators described fatal hemorrhages in the dog after lumbar aortic puncture. Burns and Hendon [6] report dos Santos' criticism of this experimental work by pointing out that the anatomy and physiology of the dog are not strictly comparable to those of the human and that doses of dye used far exceeded the amount employed clinically. Nelson [7] and Doss and associates [8] independently introduced the use of translumbar aortography in the United States in 1942, but by 1946 Doss,[9] Nelson,[7] and Wagner [10] were the only Americans with considerable experience in the field.

Although various complications and sequelae had been noted, the first death as a result of the procedure was apparently that of Wagner and Price's patient,[11] in 1950. This patient died seven hours after aortography with x-rays showing dye in the superior mesenteric artery. Ten cubic centimeters of 80% sodium iodide was used, and, although permission for autopsy was not obtained, death was probably due to superior mesenteric artery thrombosis. Ritter [12] also mentioned a case in which the mesenteric vessels were entered, with thrombosis and death. Josselson and Kaplan [13] reported a death 20 days after aortography in which autopsy findings suggested that the changes in the glomeruli and tubules of the kidneys were on the basis of a toxic reaction from acute heavy-metal poisoning. Helmsworth and associates [14] reported a death due to this procedure in an 88-year-old woman. Coronary infarction with death as a result of the lowered blood pressure associated with the procedure was presented by Williams et al.,[15] and paraplegia with later death was described in a 68-year-old white man by Antoni and Lindgren.[16]

It is obvious that fatal complications are rare, but nonfatal sequelae which may be serious and result in permanent disability are not nearly as uncommon. Reporting of these more serious complications should be done to remind physicians that, despite the claims of its many advocates, translumbar aortography is not an entirely innocuous procedure.

In general, complications may be classified as follows:

A. Effects due to anesthetic agent
   1. Local: Drug sensitivity; cardiac or respiratory arrest
   2. General: Same as above, with attendant hazards of general anesthesia

B. Complications due to puncture
   1. Local effects: Hemorrhage; (?) dissecting aneurysm; loosening of aortic plaques with embolism; pain in back, abdomen, or extremities
   2. Misdirected needle: Puncture of kidney, extravasation, puncture of diaphragm or pleura, laceration of thoracic duct

Submitted for publication May 29, 1957.

Resident in Surgery, Presbyterian-St. Luke's Hospital. Present address: Decatur, Georgia.

C. Complications due to medium used
   1. Sensitivity
   2. Injection of medium into celiac or renal vessels with necrotizing effect, mesenteric thrombosis, hemorrhagic gastritis or thrombosis of anterior spinal arteries with paraplegia
   3. Activation of tuberculous processes by iodide in dye
   4. Lowered renal function
   5. Distant vasospasm with thrombosis of femoral artery

D. Miscellaneous
   1. Lowered blood pressure with coronary or cerebral thrombosis
   2. Neurogenic hyperexcitability
   3. Temperature rise

This paper presents six cases of complications of aortography observed at the Presbyterian Hospital of Chicago. Although the total number of aortograms that have been obtained is relatively small (about 100, excluding arteriograms and angiocardiograms), the incidence of complications is greater than one would expect from the various reports in the literature. The most frequent complication, fortunately not serious, has been pain in the back, abdomen, or extremities.

Report of Cases

CASE 1.—A 54-year-old white woman was admitted to the hospital on Aug. 7, 1955, with the complaint of pain in the left chest of three days' duration. For 22 years she had been a known diabetic and had for 3 years suffered with bilateral thigh and calf claudication. She had been followed in the outpatient department, where the diabetes mellitus was controlled and a vascular study was undertaken. No pulses were palpable below the femoral artery bilaterally, and aortography was advised and performed in the outpatient department. The x-rays showed the aortic bifurcation and both common iliac arteries to be normal, but no filling was observed distally. Immediately following the aortographic study the patient complained of left-chest pain, aggravated by respiration. The pain became increasingly severe after two days, and she returned to the hospital, where x-rays disclosed fluid in the left pleural cavity.

On admission the patient was acutely ill, with left-chest pain. The past history disclosed that she had been diagnosed as having essential hypertension, but electrocardiograms had always been normal.

Physical examination showed T 100.8 F; P 98; R 42; B. P. 140/80. The positive physical findings were limited to the examination of the chest and extremities. There was splinting of the left chest with decreased expansion. Breath sounds were decreased at the base, which was dull to percussion. The peripheral arteries distal to the femoral arteries were not palpable.

Laboratory findings were as follows: Hb 11.5 gm. per 100 cc.; hematocrit 37%; WBC 11,900. Urine showed sugar and albumin 4+. Blood sugar normal; NPN 47 mg. per 100 cc.

On admission a thoracentesis was performed, and 300 cc. of bloody serum was obtained, which proved to be negative for neoplastic cells and acid-fast bacilli. At this time the intercostal nerves were blocked with procaine, with considerable relief from the pain. Chest x-rays showed some improvement, but a small pleural effusion remained which could not be successfully tapped. Despite apparent clinical improvement with blood transfusions, antibiotics, etc., she continued to have a spiking fever and intermittently complained of left-chest and left-flank pain. Intravenous pyelography was normal. The impression was that she had either a subphrenic or perinephric abscess. By Aug. 20, however, signs of a left perinephric abscess were unequivocally present, and, with the patient under general anesthesia, 300 cc. of purulent material was evacuated in the drainage of a large perinephric abscess. After surgery she improved considerably but later showed recurrent signs of pus under tension, and redrainage of the left flank was done. Cultures of material from the abscess resulted in a growth of hemolytic Staphylococcus albus, but blood cultures remained sterile. An episode of phlebothrombosis with nonfatal pulmonary infarction complicated her recovery period. With anticoagulants, antibiotics, blood transfusions, and supportive care, she gradually became ambulatory, and, despite profuse drainage from her flank incision, which healed slowly, she was able to be discharged to a nursing home on Sept. 27, 1955.

Comment.—Considerable discussion was provoked by this case. The opinion of some originally that this hemothorax might not be related to the aortography was never substantiated. No other cause for the bloody pleural fluid could be found. Chest films during her illness indicated an area of pneumonitis under the fluid in the left lower lung; but, on discharge, the chest had completely cleared save for some streaks of increased density at the left base. Injections of methylene blue in simulated aortography of the cadaver indicated that the position of the needle, as shown on x-ray, could have

passed through the tip of the superior pole of the left kidney, as well as the diaphragm, into the aorta. This would have been particularly true if the patient had been in the act of inspiration as the needle was advanced. It is felt that the needle produced a retroperitoneal hematoma, which later became infected, as well as injury to the diaphragm, resulting in a small hemothorax.

CASE 2.—A 64-year-old Negro woman was admitted to the hospital on Aug. 1, 1956, with the complaint of abdominal pain following aortography. She had been a patient at this hospital in April, 1956, at which time a nontoxic goiter had been removed. During the follow-up period she complained of backache, and the possibility of an abdominal aneurysm was considered. Consequently, on Aug. 1, 1956, aortography was performed, with use of local anesthesia, which demonstrated "some dye in the superficial and deep femoral arteries and a large amount of extravasation of dye along the left psoas muscle." The pain after aortography was described as "boring" in nature and confined to the upper abdomen.

Physical examination showed P 74; R 20; B. P. 180/110. The examination was essentially negative except for the following findings: There was a Grade 3, blowing precordial systolic murmur. Tenderness of the entire abdomen was present, with spasm of the left hemiabdomen, and a loud, blowing, to-and-fro murmur was heard over the entire abdomen. Neurological examination disclosed decreased sensitivity to pinprick over both lower extremities from midthigh to toes. Marked generalized muscle weakness was present, with poor voluntary motion of both lower extremities. Deep tendon reflexes were absent bilaterally.

Laboratory findings were as follows: Hb 13.6 gm. per 100 cc.; WBC 7850 per cubic millimeter; hematocrit 45%; urine negative.

By the following morning the patient had become paraplegic, with difficulty in voiding, and subsequently became incontinent of urine. Neurological examination then showed inability to move either lower extremity, a markedly distended bladder, and absence of all deep tendon reflexes of the lower extremities. There was anesthesia to pinprick below the level of L-2. Vibratory sense was preserved, but there was impairment of position sense. Lumbar puncture disclosed normal spinal fluid grossly, with normal pressures. At first the total protein was considerably elevated (236 mg. per 100 cc.; normal 15-45 mg.), but this returned to normal in a few days. Cell counts were, at first, 100 cells per cubic millimeter but also returned to normal in a few days.

Because of persistent vomiting, a Levin tube was inserted into the stomach and connected to suction. The patient was started on prednisolone, 30 mg. q. i. d., and hydrocortisone, 100 mg. t. i. d., in intravenous fluids. After three days of such therapy, blood appeared in the gastric suction material and steroid therapy was discontinued. On her fifth hospital day she began to flex the right knee, followed by slight flexion of the left. Gradual return of sensation began, with slight improvement of motor function. The bowels continued to function normally, but the urinary incontinence persisted for two weeks before any appreciable improvement became evident. Throughout this entire period the femoral pulses were present, though somewhat weaker on the left. Gradual improvement was maintained, and with the use of physical therapy the patient became able to sit in a chair. The ultimate outlook for complete motor recovery was considered poor. Six weeks after admission all deep tendon reflexes of the lower extremities bilaterally were still absent. There was marked atrophy of both calves, though the hamstring muscles remained active. She was discharged on Oct. 19, 1956. She was readmitted to Presbyterian Hospital on Feb. 2, 1957, when she presented a strangulated femoral hernia of the Richter type. At this time she was walking fairly well with support and a cane. No remarkable improvement had occurred.

Comment.—Hol and Skjerven [17] discuss the problem of paraplegia after aortography and theorize that damage to the spinal cord may be expected when blood flow through the abdominal aorta is retarded, as in thrombosis of the aorta, lowered blood pressure incidental to the procedure, and compression of the aorta by position. This retardation results in a prolonged exposure of the spinal cord vessels to the medium, which may be weakened by previous disease. Antoni and Lindgren [16] presented a case of paraplegia which they felt was due to compression of the aorta by a pillow under the abdomen. They also theorized that with compression of the aorta an unusually large amount of dye may find its way into the spinal arteries, producing an intimal reaction and thrombosis.

CASE 3.—A 51-year-old white woman had previously been diagnosed as having a duplication of the right renal pelvis and ureter, with a nonfunctioning lower half of that kidney. She was admitted on Sept. 9, 1953, for aortography, which was accomplished with local anesthesia. There was considerable reaction from this procedure, with abdominal pain, headache, nausea, and vomiting. Aortograms showed "a small renal artery and

kidney on the right. The lower pole of the right kidney was small and poorly vascularized. There was an aberrant artery from the aorta which supplied the lower pole of the right kidney. Findings were consistent with atrophic pyelonephritis." The patient's abdominal pain with nausea, along with an exacerbation of the pain in her right flank, which had been present prior to aortography, continued for two days, but she was discharged on Sept. 13, feeling much better. She was readmitted on Sept. 16 with occipital headache, nausea and vomiting, anorexia, and right upper-abdominal and low-back pain. X-rays of the thoracic vertebrae showed moderate osteoarthritic changes with generalized osteoporosis and slight narrowing of the disk between T-10 and T-11. She remained in the hospital five days and was discharged after amelioration of her symptoms.

She was readmitted on Sep. 26, with the complaints of abdominal pain, low-back pain, and pain in both thighs and calves. When she left the hospital after her preceding admission, she was relatively asymptomatic, but with residual right abdominal and low-back pain. At 3 a. m. on Sept. 26, all the preceding pains increased in severity, and chills with fever (temperature 101.4F) developed without any accompanying urinary complaints.

Physical examination showed B. P. 138/74; T 99.2 F. The patient was moaning with acute pain and was moderately pale and dehydrated. The positive physical findings were confined to the abdomen. There was marked tenderness over the right hemiabdomen from the umbilicus inferiorly, with a maximum point of tenderness to the right of the umbilicus. Bowel sounds were active. There were diffuse low-back pain and tenderness, with a positive Murphy test in the right flank.

Laboratory findings were as follows: blood count normal; urine negative except for 4+ bacterial growth.

After five days of symptomatic treatment, her complaints abated, and on discharge she was again relatively asymptomatic. There has been no recurrence of her complaints.

Comment.—The patient had a long history of typical migraine and a recent history of right-flank pain, but until her aortography had not experienced abdominal or low-back pain. Although there is undoubtedly a cause-and-effect relationship in this case, the precise nature is somewhat obscure. No evidence of dye extravasation was apparent, and none of the celiac vessels appeared to contain dye. It was felt that she may have sustained a chemical pyelonephritis, but numerous urinalyses and kidney function tests were unable to verify this. It is most likely that the primary basis for her complaints was a retroperitoneal hemorrhage, the effects of which were enhanced by an underlying emotional instability. The labeling of a patient as psychoneurotic, however, in no way relieves the procedure of its role in the etiology of undesirable sequelae. Procedures such as these should be used with caution in the emotionally unstable patient, particularly if the information received cannot justify its use. All physicians are aware of many instances of prolonged backache following simple subarachnoid puncture. Although in most instances it is obvious that the problem is largely a functional one, the backache must be considered a complication of the procedure.

CASE 4.—A 53-year-old white man was first admitted to this hospital on March 24, 1957, with the complaint of intermittent claudication in the left thigh, which began while he was hunting in October, 1950. The pain would begin after walking one-half block at a normal pace. He had been taking tolazoline (Priscoline), and later nicotinic acid and Buerger's exercises. At that time it was noted that the femoral pulse was considerably diminished on the left. Skin temperatures and oscillometric findings were normal, and x-rays showed no arterial calcification in the lower extremities. With the exception of a low platelet count (280,000; normal 400,000-600,000), laboratory studies were normal. He was discharged without treatment with the diagnosis of arteriosclerosis obliterans, and possibly a femoral or iliac aneurysm, to return as an outpatient for aortography.

He was readmitted on April 15, seven hours following aortography, with the complaint of right paralumbar and upper abdominal pain with nausea and vomiting. The aortogram was interpreted as follows: "Aortography was performed with 50 cc. of 70% sodium acetrizoate (Urokon). The injection was made at the level of the renal arteries. Very marked concentration of contrast material was observed in the right kidney. The aorta was well outlined. The lower 3 in. (7.5 cm.) were atherosclerotic. There was narrowing at the origin of the right common iliac artery. The left iliac artery appeared normal. There was no marked collateral circulation suggesting any degree of obstruction. Both the superficial and the deep femoral arteries appeared normal, as did the arteries in the lower leg."

Physical examination showed T 103 F; B. P. 164/88 (previously 112/80). He was markedly

apprehensive, with severe right costovertebral angle pain. There was considerable tenderness over the right lateral abdomen with spasm of the lumbar muscles below the 12th rib. Bowel sounds were active. Pulses were unchanged from those on the preceding admission.

Laboratory findings were as follows: Hb 14 gm. per 100 cc.; WBC 13,450, with normal differential count; hematocrit 43%; NPN 41 mg. per 100 cc.; normal blood chemical constituents. Urine showed 1+ protein and 20-30 white cells (repeat urinalysis the following day: 3+ protein, 50-100 white cells, negative culture).

After two days of conservative treatment, consisting of bed rest, penicillin, streptomycin, sedation, and intravenous fluids, the severity of his symptoms gradually subsided, and he began taking liquids by mouth. The temperature, which had ranged between 101 and 103 F. for 36 hours, slowly fell, with decreasing spikes, over several days. Urinary output was always adequate, ranging from 900 to 3600 cc. per day. The urine remained positive for protein for five days, with a specific gravity as high as 1.021. His weight showed a gradual loss, then a gradual climb to normal limits. By the third hospital day the blood pressure had returned to normal. After the fifth hospital day the urine returned to normal, and intravenous pyelography disclosed no abnormalities.

Comment.—It appears clear that this man had a chemical pyelonephritis, which, fortunately, disappeared rather quickly. Similar cases were not uncommon when the use of sodium iodide was widespread. With the introduction of acetrizoate (Urokon) and iodopyracet (Diodrast) compounds, lowered kidney function as a result of concentrated dye in the renal arteries is much less common. The ideal contrast material has yet to be introduced, however.

CASE 5.—A 51-year-old white man was admitted to Presbyterian Hospital on July 20, 1956, with the chief complaint of abdominal pain and faintness, beginning three hours after performance of translumbar aortography. The patient had been hospitalized here previously because of marked arterial hypertension. The history of hypertension dated back to 1946. He had been under medical management with hexamethonium and tranquilizers. In 1954 he underwent a bilateral thoracolumbar sympathectomy, after which temporary relief was obtained. For two months prior to his last admission he had complained of vague abdominal pains, and an aortogram was performed to rule out the possibility of an aortic aneurysm. Three hours after the procedure pain developed in the abdomen with sweating, nausea, and vomiting.

Complete physical examination showed T 97.8 F; P 94; R 20; B. P. 140/100. The patient was obese, pale, and in great distress. Moderate tenderness was present in the left costovertebral angle, with muscle spasm. Bowel sounds were absent. Pulses were present in the lower extremities and equal on the two sides. Neurological examination was negative. The aortogram was reported as normal.

Laboratory findings were as follows: Hb 12 gm.; WBC 20,000, with 84% polymorphonuclear leukocytes. Urine: specific gravity 1.040; albumin 3+. X-rays of abdomen negative.

By the following day the patient had improved, though the blood pressure had dropped to 112/80 and the hemoglobin to 10.6 gm. per 100 cc. The urine was negative for porphyrins. For several days the patient got along well, but then began to have a spiking, low-grade fever, the temperature reaching 101.4 F orally, followed by chills. The urine varied from normal to a 3+ reaction for albumin. Nonprotein nitrogen on the fifth day of illness was 48 mg. per 100 cc. By the 17th hospital day a palpable mass appeared in the left flank, and the hemoglobin dropped from 14.2 to 9.8 gm. per 100 cc. An x-ray report stated: "The small bowel, particularly the upper jejunum lying in the left midabdomen, is displaced anteriorly. There is no intrinsic defect. This suggests a retroperitoneal mass." Barium studies of the colon showed the left colon to be displaced to the left and slightly anteriorly. The mass was thought to lie medial to the left colon. After 2000 cc. of whole blood, the blood hemoglobin returned to 10.2 gm. and the hematocrit to 32%. The temperature fell by lysis, with no overt cause; blood and urine cultures were consistently negative for bacterial growth.

Comment.—Undoubtedly this man had a retroperitoneal hematoma from the aortic puncture. No other adequate explanation for the mass in the left flank is satisfactory. A perirenal abscess was considered, particularly in view of the temperature; but as the mass became more obvious, the temperature fell, and the physical findings did not suggest an inflammatory process. A neoplasm was also considered, but with the history and nothing to substantiate such an opinion, the idea was discarded. Although this complication did not prove to be serious, it was none the less a painful, expensive, and harassing experience, not to mention the potential hazards, among which would be the risk of whole-blood transfusions.

CASE 6.—A 25-year-old white man was admitted to the hospital on Oct. 10, 1955, for backache of three years' duration, which recently had become increasingly intense. He had been studied in another hospital, where a diagnosis of agenesis of the left kidney had been made.

Physical examination was negative except for some tenderness in the left costovertebral angle.

The blood cell count was negative. Urine, negative except for 5-10 red cells per high-power field.

The day following admission a translumbar aortographic study was performed, with local anesthesia. There was extravasation of the medium, which "extended upward into the mediastinum. The aorta and its branches were not visualized." Immediately after aortography the patient complained of severe pain in the left lumbar area and the entire abdomen, which was tender and rigid. Morphine was required to relieve the pain and tenderness in the left flank, which persisted for one week.

Comment.—This patient was one of many who complained of lumbar or abdominal pain after aortography, but the only one with sufficient distress to require hospitalization. Among the comments of other patients with pain were "Never again" and "I thought I was going to die." In neither of the latter patients, however, was an extravasation of dye present, and the x-rays of the aorta showed good filling without excessive dye in the renal or celiac vessels. It is apparent, then, that the procedure per se can be quite painful and extravasation of the dye can only contribute to the discomfort. There are those who advocate general anesthesia for the procedure. This only complicates the matter considerably. In addition to the natural risk of general anesthesia, intratracheal intubation must be considered because of the prone position of the patient. This requires either deeper anesthesia than is necessary or the use of relaxing agents, raising the level of anesthesia out of proportion to the procedure.

Comment

It is not the purpose of this paper to present a thorough review of the various complications of aortography. It is, rather, an attempt to present the untoward sequelae from a hospital performing relatively few aortographic examinations, but those by well-trained radiologists. If the incidence of important complications of this procedure is 6% in this hospital, then a true picture of the safety of translumbar aortography cannot be obtained from the literature. An indictment of the procedure is not intended; on the contrary, it is, at times, of invaluable assistance in the study of renal disease and may provide the only means whereby the vascular surgeon can ascertain the state of the aorta and its major branches preoperatively. But, as with many ancillary diagnostic studies, increasing extension of the indications for its use may bring discredit upon the method. Among the various indications are (1) complete ureteral obstruction when intravenous pyelography shows nothing and catheterization cannot be done; (2) preoperative determination of the vascular pattern of the kidney to determine whether the kidney may be partially salvaged; (3) differentiation of renal cysts from tumors; (4) demonstration of aberrant vessels, (5) Leriche's syndrome or evidence of unilateral or bilateral iliac artery occlusion. These are well-founded indications. Contraindications include (1) acute coronary occlusion or cerebrovascular accident, (2) impaired renal function, (3) skeletal deformity, making puncture of the aorta difficult or impossible, (4) allergy to dye, (5) cachexia, (6) poor hepatic reserve, (7) bleeding states, (8) advanced tuberculosis, (9) hyperthyroidism, and (10) when information to be obtained is insufficient to justify the risk.

Conclusions

Translumbar aortography is of value as a diagnostic procedure but only as an adjunct to simpler, safer, and more revealing studies. The hazards of the procedure must be carefully weighed against the probable information to be received. Six cases of untoward reactions to translumbar aortography are presented, including paraplegia, perirenal abscess, retroperitoneal hemor-

rhage, chemical pyelonephritis, and extravasation of dye with severe pain.

348 W. Ponce de Leon Ave., Decatur, Ga.

REFERENCES

1. dos Santos, R.; Lamas, A., and Caldas, P. J.: L'artériographie des membres de l'aorte et ses branches abdominales, Bull. et mém. Soc. nat. chir. 55:587-601, 1929.

2. Smith, P. G.; Rush, T. W., and Evans, A. T.: Technique of Translumbar Arteriography, J. A. M. A. 148:255-258 (Jan. 26) 1952.

3. Evans, A. T.: Renal Arteriography, Am. J. Roentgenol. 72:574-585 (Oct.) 1954.

4. Felson, B.: Translumbar Arteriography in Intrinsic Disease of the Abdominal Aorta and Its Branches, Am. J. Roentgenol. 72:597-606 (Oct.) 1954.

5. Henline, R. B., and Moore, S. W.: Renal Arteriography: Preliminary Report of Experimental Study, Am. J. Surg. 32:222-229 (May) 1936.

6. Burns, E. and Hendon, R. G.: Aortography as an Aid in the Management of Renal Lesions, Ann. Surg. 139:617-623 (May) 1954.

7. Nelson, O. A.: Arteriography of Abdominal Organs by Aortic Injection: Preliminary Report, Surg. Gynec. & Obst. 74:655-662 (March) 1942.

8. Doss, A. K.; Thomas, H. C., and Bond, T. B.: Renal Arteriography: Its Clinical Value, Texas J. Med. 38:277-280 (Aug.) 1942.

9. Doss, A. K.: Translumbar Aortography: Its Diagnostic Value in Urology, J. Urol. 55:594-606 (June) 1946.

10. Wagner, F. B., Jr.: Arteriography in Renal Diagnosis: Preliminary Report and Critical Evaluation, J. Urol. 56:625-635 (Dec.) 1946.

11. Wagner, F. B., Jr., and Price, A. H.: Fatality After Abdominal Arteriography: Prevention by New Modification of Technique, Surgery 27:621-626 (April) 1950.

12. Ritter, J. S.: Aortography, J. Urol. 73:155-161 (Jan.) 1955.

13. Josselson, A. J., and Kaplan, J. H.: Fatal Reaction Following Aortography with Neo-Iopax, J. Urol. 72:256-260 (Aug.) 1954.

14. Helmsworth, J. A.; McGuire, J., and Felson, B.: Arteriography of the Aorta and Its Branches by Means of Polyethylene Catheter, Am. J. Roentgenol. 64:196-213 (Aug.) 1950.

15. Williams, A. J.; Fullenlove, T. M., and Bryan, J. R.: Aortography: Discussion of Technique and Complications, California Med. 80:165-167 (March) 1954.

16. Antoni, N., and Lindgren, E.: Steno's Experiment in Man as Complication in Lumbar Aortography, Acta chir. scandinav. 98:230-247, 1949.

17. Hol, R., and Skjerven, O.: Spinal Cord Damage in Abdominal Aortography, Acta radiol. 42:276-284 (Oct.) 1954.

Surgery in Conjoined Twins

EDWARD W. JENKINS, M.D.; T. RICHARD WATSON, M.D., and WILLIAM T. MOSENTHAL, M.D., Hanover, N. H.

The delivery of conjoined twins is a rare occurrence, and few physicians will be called upon to handle the problems of birth and survival of these infants in a lifetime of practice. However, with the general improvements in medicine and surgery, one may anticipate more of these twins to survive and present the clinician with many difficulties. Aird has made an estimate, based on his own experience and an excellent review of the subject,[1] that there will be a half-dozen cases of conjoined twins capable of being separated annually. We therefore feel that, despite the rarity of the condition, the experience in this matter should be documented for future reference. We shall attempt to present the difficulties encountered in the case of thoracopagus twins treated at the Mary Hitchcock Memorial Hospital, with a brief discussion of the topic.

The incidence of double monsters is approximately 1 per 50,000 births.[2] Potter found 1 case in 60,000 births at the Chicago Lying-in Hospital.[3] Female double monsters are two to three times as frequent as male.[2] The most commonly reported type of conjoined twins is that of thoracopagus, estimated to occur once in 82,000 deliveries.[4]

Double monsters are structurally related to monozygotic twins. It is conceivable that twins may be joined from fusion of the closing edges of the neural groove or fusion of some other epithelial surface with the underlying mesodermal masses. It is more readily assumed, although never proved, that conjoined twins are monovular and are the result of fission of the embryo.[3]

In the past, the question of surgical correction of this abnormality has seldom arisen because of the associated stillbirth. Furthermore, if the twins are born alive, the survival period has been of short duration. After an apparently thorough search through the world literature, Aird was able to locate 36 documented instances of conjoined twins that survived and developed after birth. The earliest case recorded is the "Biddendon Maids," of England, who were born in the 12th century with a single pair of upper and lower extremities. In the 15th century the "Scottish Brothers" were born joined from the waist down but separate above. They lived 28 years at the Court of James III of Scotland. There have been others who have had a sufficient life span to become famous. The best-known pair in this country were Eng and Chang, the renowned Siamese twins born in 1811 of Chinese parents, in Siam, and exhibited by P. T. Barnum.

The earliest attempt at surgical correction is said to have been made by Dr. Farius, of Basle, in 1689. The first successful separation of conjoined twins was performed in 1912 at the Military Families Hospital, Portsmouth, England. One sister died at the age of 4 months, of pneumonia, but the other was last reported alive and well, at the age of 41.[1]

The operation is hazardous if a vital organ is shared. Success in the past has been

Submitted for publication June 12, 1957.

The Departments of Radiology, Pathology, Anesthesiology, and Pediatrics assisted in this study, which was supported in part by the New Hampshire Heart Association.

Resident Surgeon, Hitchcock Clinic, Hanover, N. H.; now Resident Thoracic Surgeon, University Hospital, Ann Arbor, Mich. (Dr. Jenkins). Department of Cardio-Pulmonary Physiology, Hitchcock Clinic, Hanover, N. H. (Dr. Watson). Department of Surgery, Mary Hitchcock Memorial Hospital (Dr. Mosenthal).

obtained most commonly when the pair is joined by the skin, subcutaneous tissues, or cartilage. Surgery is feasible when the degree of fusion constitutes a union of the superficial tissues, and most separations are precluded by the relationship of vital organs. Our case represents an example of the latter in which two otherwise well-formed female infants were joined by the anterior chest wall and upper abdomen. They shared a common pericardial sac and profoundly bizarre heart. There was also a single liver with ramifications of two different biliary systems. The liver was divided externally only by a peritoneal curtain, which allowed roughly one-half of the organ to lie in each separate peritoneal cavity. Both the pleural and the peritoneal cavities were separate and intact. The following report summarizes our case from birth to surgery, and finally autopsy. In this case, it was initially decided that surgery would be deferred until one of the twins died or its physical condition endangered the other.

Report of a Case

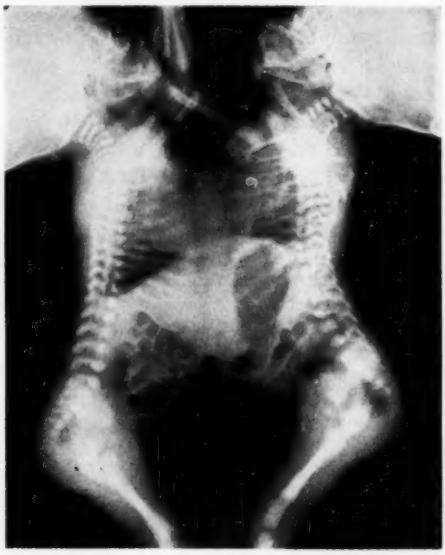
On Jan. 11, 1956, at 7:45 p. m., Dr. E. B. McGregor, of Lisbon, N. H., delivered a thoracopagus monster weighing 6 lb. 11½ oz. (3047 gm.). The mother was a secundipara, secundigravida, healthy, 25-year-old, white woman, who had previously delivered a normal 5 lb. 9 oz. (2523 gm.) daughter, on April 17, 1951. The father was 30 years of age and in general good health. Dr. McGregor stated that the delivery was uneventful up to the time one head delivered but did not descend properly. One arm delivered, and then another arm. It was rather disconcerting to find both to be right arms. Then another arm appeared, and finally a second head was delivered. The first twin presented in LOA position and rotated to LOP. The second twin's head was flexed upon the abdomen. There were a single amniotic sac, one cord, and one placenta. The twins were placed in an incubator at birth and transferred to the Mary Hitchcock Memorial Hospital.

Fig. 1.—Conjoined twins prior to separation. Baby A is on the right.

The infants were identified as Baby A and Baby B. Baby A was larger but less active than Baby B. The infants were joined from the suprasternal notch to the umbilicus. This junction extended bilaterally to the anterior axillary lines. Respirations were of equal rate but not synchronous, at 40 excursions per minute. The heart rate, of 140 per minute, was identical with the femoral pulsations in all four lower extremities. The ribs of one joined those of the other approximately where the anterior curvature usually commences. X-rays were interpreted as showing a common heart and common liver.

It was noted that each twin cried until fed even if the opposite twin had been nourished. Baby A, being the less active, suffered abrasions and contusions about the head and neck as a result of beatings from her mate. Survival was uncomplicated for three weeks, when it was noted that Baby B was not taking all of her formula. On the 29th day, Baby B demonstrated shallow respirations, periods of apnea, and mild cyanosis. The

Fig. 2.—X-ray demonstrating a common liver and heart.



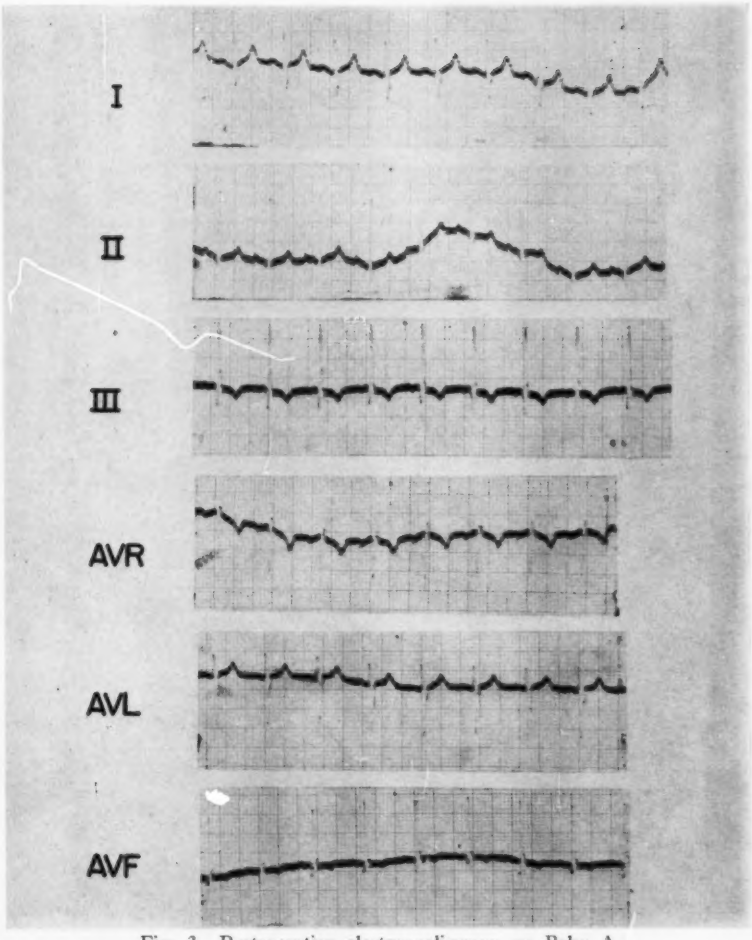


Fig. 3.—Postoperative electrocardiogram on Baby A.

heart rate was 160. There was only sluggish response to stimuli. Meanwhile, Baby A was overactive and maintained good color. Baby B was intubated with a No. 0 intratracheal tube, and a small amount of sputum was aspirated. A bronchoscope was then inserted. No obstruction of the trachea or the main bronchi was found. Oxygen given under slight pressure did not aerate the lungs. Fluoroscopy revealed normal pulmonary ventilation and good diaphragmatic motion in Baby A. Although the diaphragm appeared to be continuous across the midline, no motion could be seen on the Baby B side. A small amount of iodized oil U. S. P. (Lipiodol) inserted into the stomach and rectum of Baby A demonstrated a separate gastrointestinal tract. The diagnosis of massive collapse of the lungs of Baby B was made.

It was felt that the only hope of preserving life in Baby A lay in an attempt at surgical separation

On Feb. 9, Baby A was given preoperative medication, consisting of atropine 0.1 mg. intravenously. Light anesthesia induced by the nitrous-oxide-oxygen intratracheal, nonrebreathing technique was used.[5] Anesthesia time was recorded from 9:58 a. m. to 5:30 p. m.

A plastic intravenous catheter was inserted into the right femoral vein of Baby A, who was placed in the right lateral decubitus position. The area was draped and a vertical incision was made along the anterior axillary line of Baby B, and the right pleural cavity was entered. Manual and visual exploration revealed separate pleural cavities with a single heart lying in a single, closed pericardial sac in the center of the thoracic bridge. A definite anatomical division of the diaphragm could not be discerned between the two infants. The plan for separation was revised to perform the least hazardous operation. Previous review of the litera-

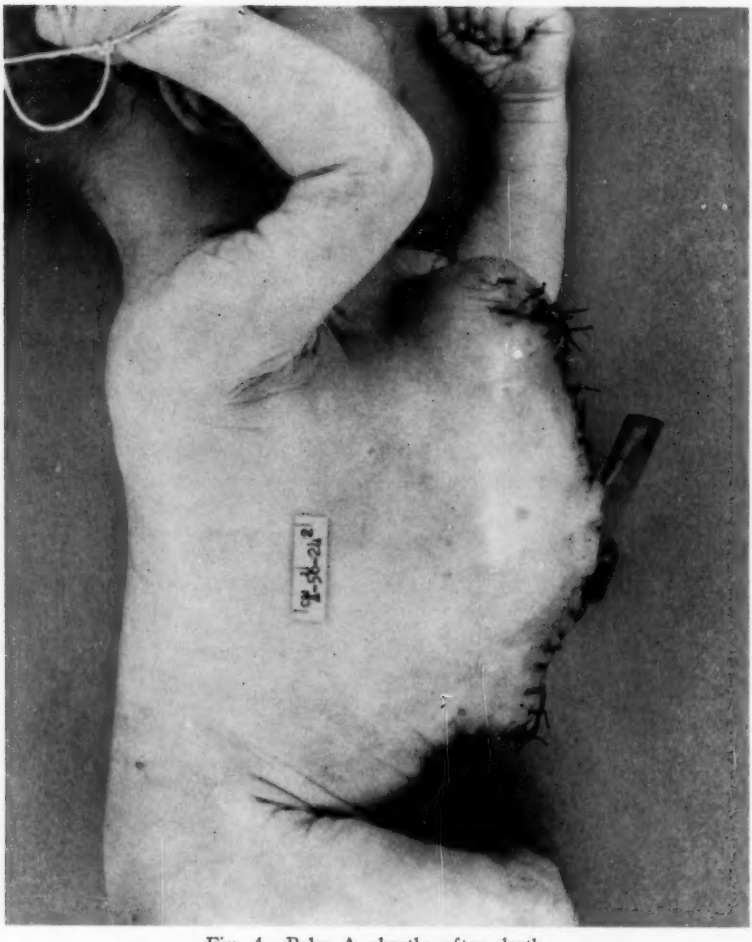


Fig. 4.—Baby A shortly after death.

ture offered very little help. It was decided to separate the two bodies, leaving the lungs of Baby B attached to Baby A and complete the hilar dissection, when the vessels would be maximally exposed. Dissection was therefore started in the superior thoracic region and continued until all the extrahilar vessels were tied and ligated, including the superior and inferior venae cavae, the aorta, and all the cervical vessels. Dissection was carried through the first ribs and the clavicles posterior to the trachea. The incision was then continued to the abdomen, dividing the diaphragm. The peritoneal contents were then removed, except for the liver and the upper part of the stomach. It was felt that the stomach and the esophagus would be more easily removed with the lungs. Baby A's peritoneal cavity was not opened. It was felt that hepatic resection was not feasible at this operation, and the entire organ was left. The remaining lateral body wall was then incised and the body of Baby B thereby removed. A bilateral pneumonectomy was then performed, with complete bilateral hilar dissection, on the lungs of Baby B. The chest wall was approximated by revision of the resected rib ends after the abdomen had been closed. A drain was inserted beneath the ribs external to the pericardium because of the large dead space left when the ribs were approximated anteriorly.

Baby A tolerated the stress of this long operative procedure well. The immediate postoperative condition was satisfactory, although the respirations were not full or vigorous. It was thought that, with constant supervision and assisted respiration, there was a reasonable chance for survival. Despite constant attendance by nurses and physicians, how-

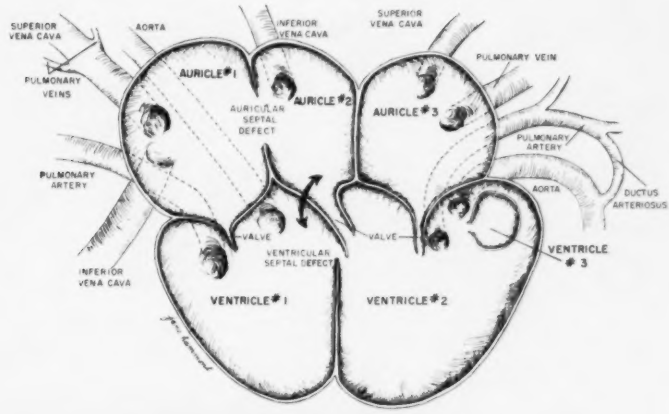


Fig. 5.—The heart shared by conjoined twins.

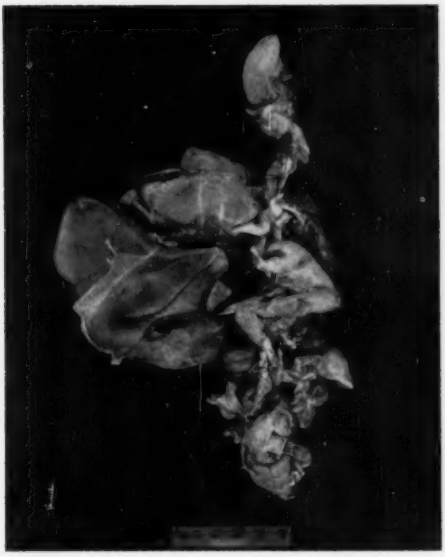


Fig. 6.—The viscera of Baby A. The tongue, trachea, and esophagus are at the top. The heart rests on the liver. Two gallbladders may be seen. The gastrointestinal tract, kidneys, bladder, and uterus may be seen to the right, below.

ever, Baby A gradually showed less and less activity and finally died at 11:35 p. m., six hours following completion of the operation.

Postmortem examination of the separated twin was performed. The immediate cause of death was diagnosed as bronchopneumonia in each. As separated individuals the findings in each twin were unremarkable for age and sex except for the connecting soft tissues and the deformed costal cartilages, the common pericardial sac and heart, and the continuity of the liver. The heart was remarkable, and its physiologic dynamics can only be theorized. There were three auricles and three ventricles. There were two separate septal defects, a patent ductus arteriosus, a common ventricular origin of both aortas and pulmonary arteries, and other bizarre formations, best demonstrated by the accompanying diagram.

Conclusions

Although survival of conjoined twins after birth remains a rarity, this abnormality may be encountered more frequently with the improvements in modern obstetrics, anesthesia, and medicine. Likewise, the surgeon may be called upon to determine the possibility of separation. If the conjoined twins have a known full complement of organs necessary for individual life, operation for separation should be undertaken, however great the risk. The operation is hazardous when a vital organ, such as the heart or brain, is shared. Surgery in such a situation should be deferred until the condition of one twin endangers the life of the other. Success in such an event will depend upon the degree the common organ is deformed by the embryonic fission.

Summary

A brief historical background and the etiology of conjoined twins is presented. A case of thoracopagus twins that survived 30 days is described. Surgical separation was performed, after the death of one twin. Death in the remaining infant occurred six

hours after operation because of a cardiac anomaly that was incompatible with life.

Hitchcock Clinic.

REFERENCES

1. Aird, I.: The Conjoined Twins of Kano, Brit. M. J. 1:831-837, 1954.

2. Scammon, R. E.: Fetal Malformations, in Pediatrics, edited by I. A. Abt, Philadelphia, W. B. Saunders Company, 1925.

3. Potter, E. L.: Pathology of the Fetus and Newborn, Chicago, Year Book Publishers, Inc., 1952.

4. Mortimer, B.; Kirshman, J. D., and Fields, J. E.: Human Thoracopagus Monster (So-Called Siamese Twins): Case Report and Anatomical Study, Am. J. Obst. & Gynec. 42:132-136, 1941.

5. Heller, M. L.; Nyboer, J., and Storrs, R. C.: Nitrous Oxide-Oxygen-Curare Anesthesia for the Geriatric Patient, Anesth. & Analg. 34:121-150, 1955.

Effect of Permanent Alteration of Hepatic Blood Flow upon Biliary Secretion

BERNARD FISHER, M.D.; SIL H. LEE, M.D., and E. J. FEDOR, Ph.D., Pittsburgh

It has been reported previously from this laboratory that following arterialization of the liver approximately 10% of the animals died of acute cholecystitis, and at autopsy common ducts were found distended with biliary "sludge." [1] This suggested that perhaps the marked increase in hepatic blood flow attendant on this procedure had altered the character of the bile. Investigation of the literature concerning the relationship of the hepatic blood flow to volume and composition of bile revealed conflicting and incomplete information obtained under conditions not entirely satisfactory.

Recently Popper and associates [2] reported that four dogs with complete external bile duct fistulas showed practically no change in secretion following excision of the hepatic artery, or obstruction of the portal vein, or a combination of the two, and they concluded that the blood of the hepatic artery and/or portal vein is not necessary for bile formation. Because of the variability of results obtained, they did not feel justified in making definite conclusions concerning the effect of devascularizing procedures on the bilirubin content of the bile. Almost all investigation on the relation of hepatic blood supply and bile formation was done before the turn of the century and consisted, for the most part, of acute experiments which were concerned primarily with qualitative observations upon bile flow following ligation of the hepatic artery and the portal vein. The chief point of consideration was whether or not hepatic arterial or portal venous blood was the main source of bile formation. Malpighi (1699),[3] Phillip (1833),[4] Schiff (1862),[5] Betz (1862),[6] Asp (1873),[7] Wertheimer (1892),[8] Colasanti (1896),[9] von Haberer (1906),[10] and Cameron and Mayes (1930) [11] all reported no change in bile production following hepatic artery ligation, while Henle (1873) [12] and Heidenhain (1883) [13] reported a depression of biliary secretion. Differences in results were also reported following ligation of the portal vein. Phillip (1833) [4] reported no alteration in biliary secretion, while Schiff (1862) [5] noted immediate cessation of flow.

The first reference to the effect of Eck fistula upon biliary secretion was that of Voegtlin and Bernheim in 1910.[14] Without presenting quantitative information, they concluded that alteration of portal flow via portacaval shunt did not prevent the formation of bile, but that the amount of bile formed by the liver did depend on the blood flow through the organ. The first quantitative data to be presented were those of Whipple and Hooper in 1917,[15,16] who demonstrated in four dogs with external fistulas no decrease in bile volume in three of the four, but a substantial decrease in bile pigment in all four animals following portacaval shunt. In 1930 Smith and Whipple [17] concluded from studies on two dogs with external fistulas that animals having Eck-type portacaval shunts show a subnormal, or even a great, decrease in bile salt output. This finding was similar to the report of Foster, Hooper, and Whipple in 1919 [18] on one dog having a different diet. Tanturi and Ivy (1937),[19] reevaluating the relation-

Submitted for publication May 13, 1957.

Supported by U. S. Public Grant A-369 (C) 3 (Dr. Fisher). John and Mary Markle Scholar (Dr. Fisher).

From the Department of Surgery, Section of Experimental Surgery, University of Pittsburgh School of Medicine.

ship of the hepatic blood flow to biliary secretion because of conflicting experimental evidence, concluded from a series of acute experiments, with the animals under anesthesia, that (*a*) complete exclusion of the portal flow decreases the volume of bile to an average extent of 50%, (*b*) markedly increasing the portal flow by arterioportal anastomosis results in a uniform decrease in bile flow, and (*c*) a "normal" increase as a result of colonic irrigation with warm tap water augments the volume output of bile.

Kjellgren [20] reported in 1955 that epinephrine given in physiologic doses to rabbits during acute experiments, although presumably increasing hepatic blood flow, had no effect on bile volume. When the drug was given, however, in large, unphysiologic doses, there was a reduction or an abolition of secretion.

Aside from these several acute experiments, in which the effect of anesthesia and the reaction to operation might well influence the results, no other data are available concerning the effects of increases in hepatic blood flow upon the bile. Also, it would seem that present knowledge concerning the effects of the portacaval shunt on biliary secretion is based entirely upon a few experiments in animals with external biliary fistulas on various diets and conditions, making interpretation of results most difficult. Thus, it seemed worth while to evaluate quantitatively the effects on biliary secretion by permanently increasing the hepatic blood flow through arterialization and by decreasing it with portacaval shunt.

Methods

Thirty-two trained mongrel dogs of both sexes, averaging 10.7 kg. in weight, were divided into three groups. All animals, under pentobarbital sodium anesthesia, were cholecystectomized and had modified Thomas[21] stainless-steel cannulas with threaded screw caps inserted. The duodenal fistula was placed opposite the ampulla of Vater in such a manner that when bile samples were to be collected the unanesthetized animal was placed on its side, the cap removed, and a stiff-woven catheter readily inserted into the common duct. The catheter was prepared so that it would be wedged into the ampulla, prohibiting the leakage of bile around it. Bile was collected with all animals in the erect position, supported but not immobilized. Collections were made twice daily—from 9 to 10 a. m. and from 3 to 4 p. m. After the samples were taken, catheters were withdrawn and the screw caps replaced, permitting bile to flow in normal fashion into the intestinal tract. All animals were uniformly fed a diet of Friskies dog meal after the afternoon collection of bile.

Thirteen dogs having no other operative procedure served as controls. Simultaneous with insertion of metal cannulas, 9 animals were subjected to hepatic arterialization, and 10 had end-to-side portacaval anastomoses. These operative techniques were previously described in detail from this laboratory.[22] Arterialization was accomplished by end-to-side portacaval shunt and the interposition of an autogenous vein graft between the proximal end of the portal vein and the aorta.

After surgery all animals were permitted to recover from the immediate effects of the operation. Bile collections were not started until the dogs began to eat and were active. Sampling was continued twice daily for at least a week, and up to three weeks after operation in some animals.

Aside from noting the volume secreted, quantitative estimation of cholic acid was determined by the method of Irvin, Johnston, and Kopala,[23] total and free bile cholesterol as described by Foldes,[24] and total bilirubin by the method of Malloy and Evelyn.[25] All data were subjected to statistical analysis utilizing Fisher's *t*-test. *P* values of 0.01 were considered to be significant.

Hepatic blood flow values referred to were obtained using the sulfobromophthalein (Bromsulphalein) method of Bradley.[26]

Results

Fluctuations from day to day of volume and composition of bile occur even when the bile is obtained from dogs without external fistulas under controlled conditions. Collective results from all animals are presented in the accompanying Table.

Bile Volume.—One hundred thirty-four morning and afternoon samples of bile col-

Estimated Hepatic Blood Flow Following Arterialization and Portacaval Shunt

	No. of Dogs	Estimated Hepatic Blood Flow	
		Ml/Min.	Ml/Kg/Min.
Normal	20	571 ±122	49 ±7
Arterialized	12	1142 ±183	113 ±26
Portacaval shunt	12	226 ±69	25 ±5

lected from the 13 control dogs, weighing 10.7±1.7 kg., revealed a statistically significant difference in the morning and afternoon bile volumes, the *P* value being 0.01. Ninety collections in nine arterialized animals, weighing 10.7±1.3 kg., showed no statistical difference in volume from the normal, either in the morning or in the afternoon, *P* values being 0.9 and 0.2, respectively. Likewise, 92 samples from 10 animals with end-to-side portacaval shunts failed to differ in volume from those of the control animals, *P* values being 0.8 and 0.7.

Cholic Acid.—As with the bile volume, a statistically significant difference exists in total amount of cholic acid between the morning and the afternoon samples in the normal, arterialized, and shunted animals. There is no difference, however, either in the morning or in the afternoon, in amount or concentration of bile salts between the control group and the animals having alteration of hepatic blood flow. Mean values alone would suggest that there is a decrease in cholic acid in the portacaval-shunted animals. However, the variations about the averages are so great that analysis of data reveals no statistical difference in the groups. For example, comparison of control a. m. to portacaval-shunt a. m. samples shows the cholic acid (milligrams per hour) to have a *P* value of 0.3, whereas for the afternoon this is 0.2. When expressed as milligrams per kilogram per hour, *P* values for both a. m. and p. m. are 0.2.

Bilirubin.—No significant difference in bilirubin output of bile exists among the control, arterialized, and portacaval-shunted animals. Unlike the bile volume and cholic acid concentrations, no difference exists between a. m. and p. m. bilirubin concentrations of animals in any of the three groups. *P* values in any comparison are all much greater than 0.01, with no figure even approaching significance.

Cholesterol.—Values for total cholesterol in bile are indicative of the free cholesterol, for the latter fraction represents almost 100% of the total biliary cholesterol. When applied to statistical analysis, no difference is found for this constituent between the control animals and the dogs with altered hepatic circulation, even though, as with cholic acid, mean values would suggest such a difference. Likewise, the amount and concentration in the morning and afternoon samples from the control animals are similar.

Comment

The effect of arterialization and of portacaval shunt upon the estimated hepatic blood flow is shown in the accompanying Table. These values were obtained on unanesthetized animals in this laboratory during the course of other experiments. Results presented would indicate that with a total hepatic blood flow ranging from 25 to 113 ml/kg/min., which is approximately one-half to two and one-half times normal flow, there is no alteration in either volume or consumption of bile. Contrary to the findings of Whipple and co-workers [15,17] and to general opinion in the surgical literature, when the metabolic effects of the Eck fistula are considered, no discernible difference in bile from shunted and control animals was noted. Further, the report of Tanturi and Ivy [19] that "an increase in portal flow accompanied by a marked increase in portal pressure decreases bile formation" cannot be substantiated. Under the conditions of these experiments the portal venous system carries blood at systemic arterial pressure levels. It would seem that markedly increasing the intrahepatic vascular pressure does not interfere with biliary secretion, in spite of the fact that the secretory pressure of bile, which was estimated by McMaster and Elman [27] to be 30-33.5 cm. of water at the porta hepatis, has been exceeded. This is in keeping with the conclusion of Kjellgren [20] that intrahepatic vascular pressure in itself does not affect the secretion of bile unless it leads to impaired oxygen supply to the liver, and lends support to the finding of Popper and his associates [2] that biliary secretion (volume) is apparently only dependent on hepatic blood flow insofar as it is necessary to

maintain hepatic cellular integrity. The diurnal variation in bile and cholic acid is consistent with previously reported findings in animals with external fistulas.[18] No adequate explanation for this has been proposed. Because of the great variation from animal to animal and from sample to sample in the same animal, even under the most ideal of conditions, large numbers of values must be obtained for valid interpretation of data. Although it would be ideal for each animal to serve as its own control before altering the blood flow, this was found not to be technically feasible.

The finding of biliary tract disease in animals following arterialization cannot be attributed to change in bile volume, cholesterol, bilirubin, or cholic acid, and the pathogenesis of this finding must be sought for elsewhere.

Summary and Conclusions

Because it was found that many animals with arterialized livers died of biliary tract disease, and that the literature concerning the relationship of hepatic blood flow to biliary secretion was not conclusive, the effects of permanently modifying the circulation to the liver by portacaval shunt and total arterialization upon the volume and composition of bile has been studied. Utilizing animals prepared with cannulas so that bile drained normally into their intestinal tracts, except during the periods of sampling, the following observations have been made:

1. End-to-side portacaval shunt, although reducing hepatic blood flow by approximately 50%, produces no significant alteration in bile volume, cholic acid, bilirubin, or bile cholesterol from control animals.

2. Arterialization of the portal circulation increases liver blood flow two to three times normal and elevates intrahepatic vascular pressure. No alteration in volume or composition of bile was observed.

3. Biliary secretion, both volume and content, is independent of variations of portal flow, and probably of total hepatic blood flow, except insofar as the latter is necessary to maintain hepatic cellular integrity.

Morton Levine, B.S., and Elizabeth Saffer, B.A., gave technical assistance in this study.

Section of Surgical Research, University of Pittsburgh School of Medicine.

REFERENCES

1. Fisher, B.; Russ, C.; Fedor, E.; Wilde, R.; Engstrom, P., and Fisher, E. R.: Further Experimental Observations on Animals with Arterialized Livers, Surgery 38:181, 1955.

2. Popper, H. L.; Jefferson, N. C.; Wulkan, E., and Necheles, H.: Bile Secretion and Blood Supply of the Liver, Am. J. Physiol. 181:435, 1955.

3. Malpighi, M.: De hepate, in Opera omnia, Lugd. Bat., P. vander Aa, 1699, Vol. 2, pp. 257-268.

4. Phillip, B., 1833; cited by Schiff.[5]

5. Schiff, M.: Über das Verhältniss der Leber-Circulation zur Gallenbildung, Schweiz. Ztschr. Heilk. 1:1, 1862.

6. Betz: Über den Blutstrom in der Leber, insbesondere den in der Leberarterie, Sitzungsb. k. Akad. Wissensch. math.-natur. Cl. 46:238, 1862; Ztschr. rat. Med. 18:44, 1863.

7. Asp, G.: Zur Anatomie und Physiologie der Leber, Ber. k. sächs. Gesellsch. Wissensch. Leipzig, 1873, p. 25.

8. Wertheimer, E.: Sur la circulation entéro-hépatique de la bile, Arch. physiol. norm. et path. 4:577, 1892.

9. Colasanti, G.: Contributo alla chimica della bile, Bull. accad. med. Roma 22:487, 1896-1897.

10. von Haberer, H.: Experimentelle Unterbindung der Leberarterie, Arch. klin. Chir. 78: 557, 1906.

11. Cameron, G. R., and Mayes, B. T.: Ligation of Hepatic Artery, J. Path. & Bact. 33:799, 1930.

12. Henle, F. G. J.: Handbuch der systematischen Anatomie des Menschen, Braunschweig, F. Vieweg u. Sohn, 1873, Vol. 2: Eingeweidelehre, p. 197.

13. Heidenhain, R., in Hermann's Handbuch der Physiologie, Leipzig, F. C. W. Vogel, 1883, Vol. 5, Pt. I, p. 237.

14. Voegtlin, C., and Bernheim, B. M.: Role of the Portal Circulation of the Liver in Bile Formation and Jaundice, J. Pharmacol. & Exper. Therap. 2:455, 1911.

15. Whipple, G. H., and Hooper, C. W.: Bile Pigment Metabolism: V. Bile Pigment Output Influenced by the Eck Fistula, Am. J. Physiol. 42:544, 1917.

16. Hooper, C. W., and Whipple, G. H.: Bile Pigment Metabolism: IX. Bile Pigment Output Influenced by Hemoglobin Injection in the Combined Eck Bile Fistula Dog, Am. J. Physiol. 43: 290, 1917.

17. Smith, H. P., and Whipple, G. H.: Bile Salt Metabolism: IX. Eck Fistula Modifies Bile Salt Output, J. Biol. Chem. 89:739, 1930.

18. Foster, M. G.; Hooper, C. W., and Whipple, G. H.: Normal Fluctuations in Healthy Bile Fistula Dogs, J. Biol. Chem. 38:367, 1919.

19. Tanturi, C. A., and Ivy, A. C.: A Study of the Effect of Vascular Changes in the Liver and the Excitation of Its Nerve Supply on the Formation of Bile, Am. J. Physiol. 121:61, 1938.

20. Kjellgren, K.: Biliary Secretion in Relation to the Liver Temperature and the Blood Pressure, Acta Soc. med. upsal. 60:172, 1955.

21. Thomas, J. E.: An Improved Cannula for Gastric and Intestinal Fistulas, Proc. Soc. Exper. Biol. & Med. 46:260, 1941.

22. Fisher, B.; Russ, C., and Uplegraff, H.: A Suitable Technique for Total Arterialization of the Dog Liver, Surgery 35:897, 1954.

23. Irvin, J. L.; Johnston, C. G., and Kopala, J.: A Photometric Method for the Determination of Cholates in Bile and Blood, J. Biol. Chem. 153: 439, 1944.

24. Foldes, F. F.: The Quantitative Determination of Combined Cholesterol in the Presence of Bile, J. Lab. & Clin. Med. 28:1889, 1942.

25. Malloy, T. H., and Evelyn, K. A.: Oxidation Method for Bilirubin Determinations in Bile and Meconium with the Photoelectric Colorimeter, J. Biol. Chem. 122:597, 1937.

26. Bradley, S. E.; Ingelfinger, F. J.; Bradley, G. P., and Curry, J. J.: Estimation of Hepatic Blood Flow in Man, J. Clin. Invest. 24:890, 1945.

27. McMaster, P. D., and Elman, R.: Expulsion of Bile by the Gall Bladder; and a Reciprocal Relationship with the Sphincter Activity, J. Exper. Med. 44:173, 1926.

Chylothorax Treated by Ligation of the Thoracic Duct and Studies in Thoracic Ductography

JOSEPH J. GARAMELLA, M.D., Ph.D., Minneapolis

Although first discovered in a horse by Eustachius,[1] a Roman anatomist in 1565, in dogs and other species by Asellius [1] in 1622, and in man by Veslingius [2] in 1634, the thoracic duct may be said to have yielded as a surgical organ a decade ago, when this structure was first successfully ligated by Lampson [3] for the treatment of chylothorax. Peet and Campbell,[4] in 1943, had ligated the thoracic duct for chylothorax, but their patient succumbed suddenly following the ligation, the cause of death being undetermined.

In the era prior to Lampson's successful ligation the thoracic duct was shrouded with mystery. Not only was the impunity with which the thoracic duct can be ligated unrecognized but, in addition, ligation was strongly forbidden.[5-7]

Submitted for publication March 25, 1957.

Rappaport Professor of Cardiac Research, Mount Sinai Hospital.

From the Division of Thoracic Surgery, Mount Sinai Hospital, and the Department of Surgery, University of Minnesota Medical School.

The collected cases of traumatic chylothorax are listed in the accompanying Table. Since Lampson's successful ligation, thoracic-duct ligation for the treatment of chylothorax has been performed at least 40 times without a fatality.

The purpose of this presentation is twofold: first, to report a case of traumatic chylothorax, complicating closure of an interventricular septal defect, successfully treated by thoracic-duct ligation, and, second, to submit a number of thoracic ductograms obtained in cadavers which may serve to orient and alert the surgeon to the variations of thoracic-duct anatomy.

Report of a Case

Present Illness.—The patient, a 36-year-old white woman, was admitted to the hospital on Nov. 8, 1956, with the chief complaints of fatigue and malaise, diminished exercise and work tolerance, and pain in the left chest with exercise. She had had a known heart condition, diagnosed at the age of 2½ years. Restriction of activity was recommended by her physician, but instead she was permitted to engage in all activities, including volley

Collected Cases of Traumatic Chylothorax

Author	Date	No. Cases	Therapy			Mortality
			Thoracentesis	Ligation Thoracic Duct	Other	
Shackelford and Fisher (1695–1936)	1938	41	20	0	21	50%
Lampson (1936–1948)	1948	18	7	2	9	40%
Goorwitch (1948–1954)	1954	31	10	15	6	Over-all.....10% Duct ligation (15).....0% Other (16).....19%
Baffes	1954	4	2	2		0
Elliot	1954	2		2		0
Winters	1954	2	1	1		0
Goorwitch	1955	1		1		0
Merrill	1955	2		2		0
Gilest	1955	1	1			0
Stranahan et al.	1956	3		3		0
Klepser *	1956	9		9		0
Maloney and Spencer	1956	13	11	2		0
Glenn	1956	1		1		0
Author	1956	1		1		0
Total		128	52	41	36	

* Eighteen additional cases—nonresectable carcinoma of lung. Ligation of thoracic duct.

ball and baseball. No special diagnostic procedures were carried out prior to her hospitalization. She performed all the household work involved in taking care of six children until Sept. 24, 1956, when she experienced left-chest pain with exercise and general tiredness, and noted that she had dyspnea with exertion. She had noted palpitations intermittently once or twice a week for six months. There was no history of cyanosis or swelling of the lower extremities. She had received no medication. Her weight was stable, at approximately 120 lb. (54 kg.). Shortly prior to admission she experienced chest discomfort with the slightest exertion.

Past History.—In 1932 she had pneumonia and in 1940 a tonsillectomy. She had six children, by Cesarean section. Following the sixth Cesarean section, in 1951, a subtotal hysterectomy was performed.

Family History.—The patient was the 2d of 13 siblings. There was no familial history of heart disease.

Social History.—The patient had been employed as a secretary for two and one-half years. She left her job because of her present symptoms.

Systemic Review.—This was essentially noncontributory.

Physical Examination.—Her temperature was 97.6 F, pulse 88 a minute, blood pressure 106/72 mm. Hg, and respirations 22 a minute. Her weight was 122 lb. (54.9 kg.), and her height was 5 ft. 1½ in. (156 cm.). She was well developed and well nourished, and appeared her stated age. She was alert, cooperative, and cheerful. The area of cardiac dullness extended about 6 cm. lateral to the left sternal border. A thrill was present in the third intercostal space to the left sternal border and extended to the base of the neck. The heart rhythm was regular. A Grade 3, low-pitched, harsh systolic murmur was heard all over the chest, but most prominently in the second and third left intercostal spaces. This was transmitted to the left carotid area. It was noted to a less pronounced degree in the left interscapular area. P_2 was greated than A_2.

Laboratory Data.—Hemoglobin 15.5 gm.; white blood cell count 7,450, with 62% neutrophiles, 34% lymphocytes, 3% monocytes, and 1% eosinophiles; urinalysis normal.

X-Ray Examination of Chest.—The heart was enlarged. There was an extremely prominent main pulmonary artery. The aorta was not prominent. The parenchymal vasculature was only borderline in prominence. Cardiac fluoroscopy showed considerable cardiac enlargement, primarily right ventricular; slight left ventricular hypertrophy, and a definite increase in vascular markings throughout both lungs. The findings were consistent with a congenital malformation of the heart with a left-to-right shunt. Cardiac catheterization gave definite evidence of pulmonary stenosis and an interventricular septal defect, based on the following data*: There was marked hypertension in the right ventricle, the systolic pressure varying from 73 to 87 mm. and the diastolic pressure from 1 to 5 mm. Hg. The pressure in the pulmonary artery varied from 29 to 39 systolic mm. Hg and from 9 to 19 mm. Hg diastolic. A continuous pressure tracing, which was done twice as the catheter was drawn from the pulmonary artery back into the right ventricle, showed a marked gradient of pressure across the pulmonary valve. The pressure in the right atrium was normal, varying from 1 to 4 mm. Hg at the base line, and the A waves varied from +4 to +8 mm. Hg at the peak. The pressure in the superior vena cava and the inferior vena cava was normal, varying from +3 to +7 mm. Hg. The O_2 contents per liter were as follows: (1) pulmonary artery, 154-154 cc.; (2) right ventricle outflow tract, 165-165 cc.; (3) mid right ventricle, 144-142 cc.; (4) right atrium, 129-127 cc.; (5) inferior vena cava, 125-128 cc.; (6) superior vena cava, 123-124 cc.; (7) right brachial artery, 185 cc.—95% saturation. The estimated systemic blood flow was 3.772 liters per minute; the estimated pulmonary flow was 6.936 liters per minute.

Hospital Course.—On Nov. 9, the heart was explored through a bilateral thoracotomy with transverse sternotomy at the fourth interspace. The heart was markedly enlarged. The enlargement was predominantly of the right ventricle. The pulmonary artery was also enlarged. A systolic thrill was readily palpable over the right ventricle and the pulmonary artery trunk. Cardiac by-pass was performed employing the extracorporeal heart-lung apparatus, as described by DeWall and associates.[8] The heart was electively arrested with potassium citrate.[9] Right ventriculotomy was performed, and an interventricular septal defect, approximately 3 cm. in diameter, was found in the membranous portion of the interventricular septum. This was closed with a running 00 nonabsorbable surgical (silk) suture. The pulmonary valve orifice admitted the small finger, but the commissures of the cusps were fused. These were readily split by the index finger. The duration of cardiac by-pass was 21 minutes. The duration of cardiac arrest was 13 minutes. The heart resumed normal rhythm after coronary flow was restored. The arterial pH before perfusion was 7.56 and after perfusion 7.53. The plasma hemoglobin before perfusion was 16 mg., and following perfusion 90 mg., per 100 cc. The immediately preoperative weight was 118 lb. (53 kg.); the immediately postoperative weight was 120 lb. The systolic blood pressure during the period of perfusion ranged between 70 and 90 mm. Hg and postoperatively was 90 mm. Hg. In the

* Courtesy of Rolf Andreassen, M.D., Minneapolis.

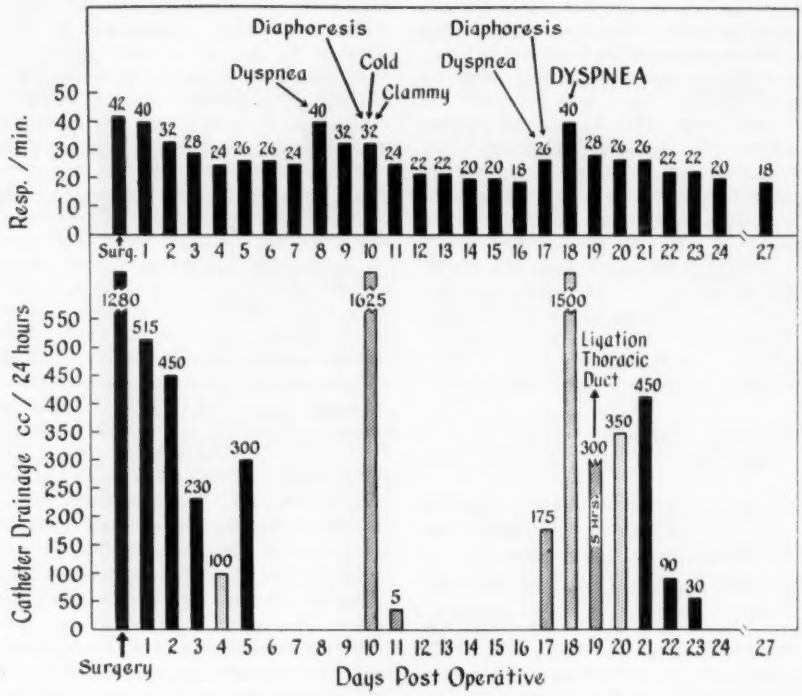
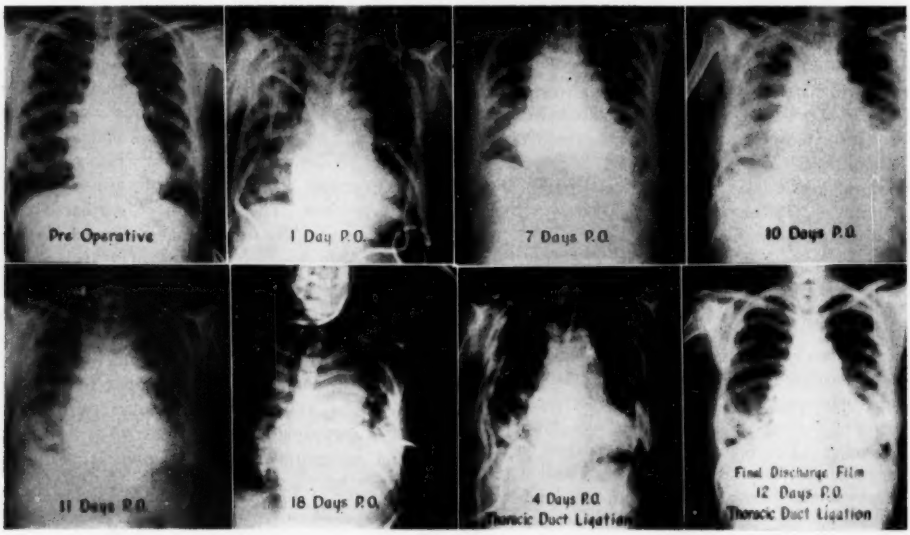


Fig. 1.—Pertinent features of the postoperative period charted, correlating symptomatology, fluid accumulation, and chest-catheter drainage. Ligation of the thoracic duct on the 19th postoperative day controlled the chylothorax.

Fig. 2.—Sequential chest x-rays, which may be correlated with the clinical features presented in Figure 1 and in the text.



recovery room the patient was conscious and responsive, and her general condition was considered excellent. The pertinent features of the postoperative course, including respiratory changes and chest catheter drainage, are summarized in Figure 1. Significant x-ray changes in the chest are shown in Figure 2. Details of the postoperative period follow.

Postoperative Course.—On the first postoperative day the patient's color was fair. There was no cyanosis. She was somewhat drowsy but had no particular complaints. The blood pressure was 76/58 mm. Hg; the pulse was 110 a minute; the skin was dry and warm. An occasional extrasystole was noted on cardiac auscultation, and there was some diminution of breath sounds on the right side posteriorly. There was no neck-vein distention. The urinary output was satisfactory. The chest x-ray was not remarkable (Fig. 2). On the fifth postoperative day the patient was feeling stronger; the respiratory rate was still increased. Her weight was 119 lb. (53.5 kg.). There were still basal rales in the lungs posteriorly. The apical heart rate was 100 per minute, and on this date there was a scanty amount of turbid, somewhat creamy drainage from the chest catheter. The possibility of this being chyle was considered. On the fifth day x-ray examination of the chest showed postoperative pleural reaction. There were patchy densities in the right lower lung field and some on the left at the level of the cardiac apex. This density appeared to have increased since the previous film. On the sixth postoperative day her general condition was good but her dyspnea continued. On the seventh postoperative day her dyspnea continued and she became more dyspneic when nasal oxygen administration was stopped. Her dyspnea continued, and on the seventh postoperative day the chest x-ray showed increased markings in the lower lung fields, suggesting pleural reaction and pneumonitis (Fig. 2). A venous pressure in the antecubital vein was 7.5 cm. H_2O on the eighth postoperative day. On that evening, after the ingestion of some toast, which the patient stated "went the wrong way," her dyspnea increased markedly, and the use of accessory muscles for respiration was noted. At that time physical examination indicated markedly decreased breath sounds on the left posteriorly, and an x-ray examination of the chest showed an increased amount of parenchymal density in the right upper and midlung field, as well as in the lingula and lower lobe on the left. The roentgenological interpretation was probable pneumonitis. In the belief that the patient had aspirated some food, tracheal aspiration was performed with a No. 16 F. catheter, and the patient seemed to be improved. The patient continued to have dyspnea, and nasal oxygen administration was continued. On the 10th postoperative day, x-ray examination of the chest showed increased density in the left base, consistent with fluid accumulation (Fig. 2). The markings throughout both lung fields were conspicuous and had a reticular pattern. Thoracentesis was performed on the left side, and approximately 600 cc. of turbid, yellow, creamy fluid, which layered on standing and had the appearance of chyle, was aspirated. A No. 18 F. catheter was inserted through a trocar, and an additional 400 cc. of similar turbid fluid was obtained. The patient obtained remarkable subjective relief of her dyspnea. The characteristics of the fluid obtained from the chest were as follows: (1) milky appearance, with an upper white layer; (2) specific gravity 1.016; (3) no odor; (4) microscopic fat demonstrable with Sudan fat stain after ether extraction; (5) no bacteria on direct smear, but many mononuclear cells identified; (6) protein, 3.2 gm. per 100 cc.; (7) no growth on culture after two days; (8) differential study of cells—100% lymphocytes. On the 10th postoperative day, D and C red #18, a coal tar derivative, was given to the patient orally in a 75 mg. capsule, and within 40 minutes red coloration of the chest-catheter drainage was noted. The chest-catheter drainage in a period of six hours was 600 cc., a rate of 100 cc. per hour. To combat the fluid loss, the patient was given 300 cc. of plasma and 1000 cc. of Ringer's injection U. S. P. At 10:30 p. m. the same day the patient was noted to be perspiring profusely. Her blood pressure was 98/64 mm. Hg; the pulse was 124 a minute, and the respirations were 28 a minute. Her skin was cold and clammy. She was anxious and appeared to be in shock. Another 300 cc. of plasma was given. She therefore received 600 cc. of plasma and 1000 cc. of Ringer's injection U. S. P. in replacement of a chest-fluid loss of 1625 cc. of chyle. On the 11th postoperative day, the patient's condition was unchanged except that the liver was palpable 2 fingerbreadths below the right costal margin. An x-ray of the chest showed improvement following catheter drainage (Fig. 2). On the 13th postoperative day marked improvement was present. Her color and appetite were good. The patient was alert, and the respiratory rate was decreased. The heart rate was still 100 a minute. Rales were heard in both bases posteriorly. Drainage from the chest catheter was minimal. An electrocardiogram showed frequent ventricular premature beats, consistent with intermittent Wolff-Parkinson-White syndrome. On the 15th and 16th postoperative days there was no change. On the 17th postoperative day, the patient was sweating profusely, was dyspneic, and there were dullness to percussion, bronchial breath sounds, and decreased tactile fremitus over the left lower chest posteriorly. A chest catheter was inserted on the left posteriorly, and 175 cc. of chylous material was obtained. On the 18th postoperative day

markedly increased dyspnea was noted. An x-ray examination of the chest showed marked broadening of the mediastinum, extending into the superior mediastinum and to the apices of the lung (Fig. 2). Thoracentesis was performed 4 cm. from the spine posteriorly on the left, and a catheter was inserted, with an immediate yield of 1700 cc. of chylous fluid. Again, marked subjective improvement occurred. On the 19th postoperative day x-ray examination showed reaccumulation of fluid in the mediastinum (Fig. 2). A third catheter was inserted posteriorly at the level of the sixth interspace (Fig. 2). Chylous fluid was again obtained. In the five-hour period after the catheter was inserted there was a collective drainage of 300 cc., a rate of approximately 60 cc. per hour. There was some reduction of respiratory distress. Because of the repeated and continued accumulation of chylous fluid, we elected to ligate the thoracic duct. Since the left lung appeared expanded and did not require decortication, we elected to operate on the right side.

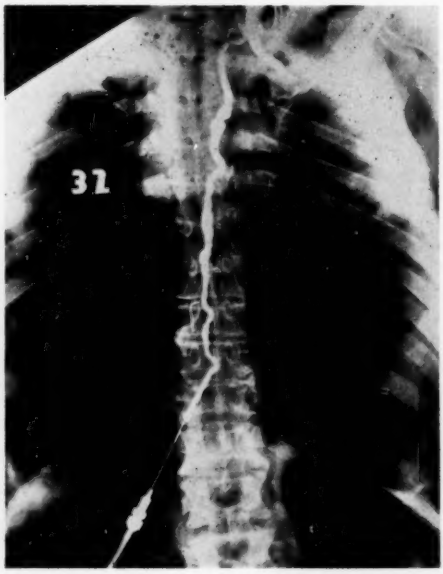
Operative Description (Nov. 28, 1956).—The patient was put in the three-quarter prone position. Thoracotomy was performed through the bed of the ninth rib. There was considerable inflammatory reaction with complete symphysis of the right pleural space. Fibrinous material covered the visceral and parietal pleurae. The lung was not congested or edematous, and there was no palpable pneumonitis. The hilar lymph nodes were markedly enlarged and boggy. Forty minutes prior to the dissection, 25 mg. of Evans-blue dye was injected subcutaneously in the thigh, as recommended by Merrill.[10] The thoracic duct and three parallel channels were very well demonstrated between the azygos vein and the aorta by the method. A ductogram was attempted; this was inconclusive. The thoracic duct and the parallel collecting structures were ligated. Appropriate chest catheters were inserted and the chest closed in layers. The chest-catheter drainage was principally serosanguineous (Fig. 1). X-ray examination of the chest on the fourth day following thoracic-duct ligation showed improvement (Fig. 2). The catheters were removed five days following duct ligation. The patient was no longer dyspneic. There was progressive weight loss noted with marked diuresis. Her weight at the time of thoracic-duct ligation was 121½ lb. (54.6 kg.), and at discharge 32 days later her weight was 107 lb. (48.2 kg.). The relation of the weight loss to the duct ligation was not clear. On the 29th postoperative day, the patient was breathing more comfortably, without oxygen. The heart rate was 95 a minute. There was no venous distention or edema. Following thoracic-duct ligation there was an abrupt decline in appetite and food intake, and her abdomen seemed distended, suggesting ascites. The liver was enlarged 2½ fingerbreadths below the right costal margin, and the spleen, 2 fingerbreadths below the left costal margin. The relation of these visceral enlargements to blockage of lymph following duct ligation was considered. On the 30th postoperative day the patient continued to show marked clinical improvement. She was ambulatory, without dyspnea. She was cheerful and alert and talked about going home. The liver and spleen were still palpably enlarged. There was some tenderness over the liver. Her weight was 106¾ lb. (48 kg.). On the 31st postoperative day the patient was anxious to go home. There had been a reversal of the albumin-globulin ratio; total protein was 7.4 mg. per 100 cc., with albumin 3.1 mg. and globulin 4.3 mg., per 100 cc. On the 32d postoperative day the patient was discharged.

Three-Month Follow-Up.—The patient had resumed activities, including dancing and ice skating.

Thoracic Ductograms

Thoracic ductograms were performed in 35 cadavers over a five-year period. The thoracic duct was isolated in most instances above the diaphragm between the azygos vein and the aorta. Cannulation was followed by injection of radiopaque medium (70% iodopyracet) without controlled pressures. In some instances the left jugular,

Fig. 3.—Thoracic ductogram. The thoracic duct has a more tortuous course. The several points of constriction with dilatation proximal and distal to the constriction are sites of valves. Note the two terminal endings of the duct.



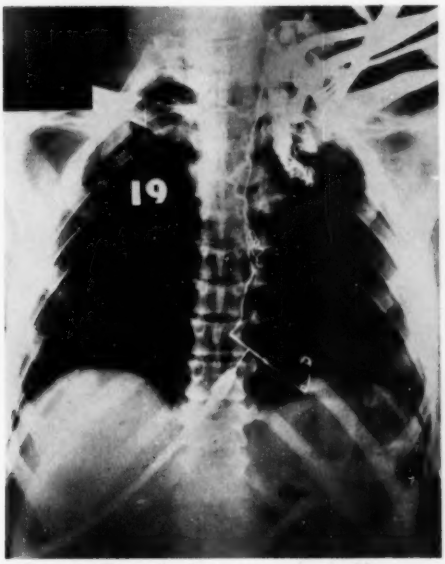


Fig. 4.—Thoracic ductogram. A plexiform pattern is present in the middle third of the thoracic duct. From the upper third a tributary is noted extending to and partially filling the right jugulosubclavian junction. In spite of multiple clamping of the left jugular, subclavian, and innominate veins, extravasation of dye is present in the left hemithorax.

Fig. 5.—Thoracic ductogram. The lymphatic collecting system in the thorax consists of a plexus of large lymphatics rather than a single trunk, as in Figure 3. Two large branches from the upper third of the system extend to the right jugulosubclavian junction. Multiple possible sites of injury in the mediastinum are apparent.

Fig. 6.—Thoracic ductogram. A plexiform pattern is present in the middle part of the thoracic duct. Valves, present at the junction of major collecting trunks, such as the intercostals, with the thoracic duct, usually prevent retrograde filling. Note that two left intercostal trunks have been partially filled in this study. Some extravasation of dye has occurred from the plexiform network.

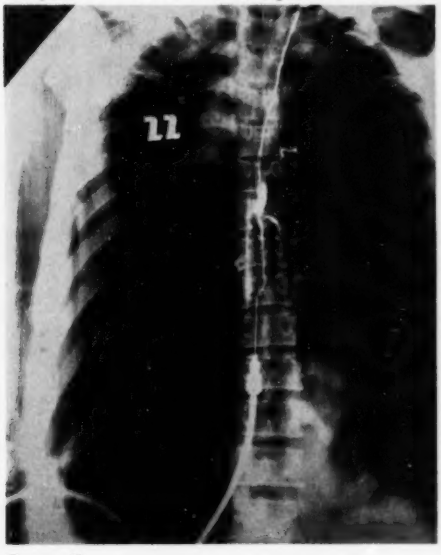
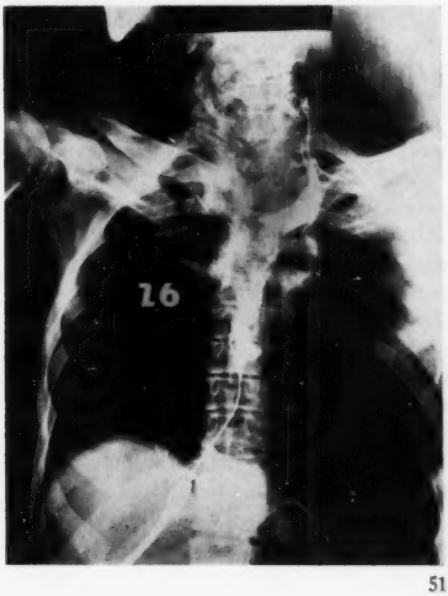


Fig. 7.—Thoracic ductogram. The thoracic duct in the midportion is formed by a large plexiform pattern, from which a single trunk arises and extends into the left side of the neck, forming the arch of the thoracic duct, emptying into the left subclavian vein. The left subclavian and jugular veins are outlined with the left innominate vein.



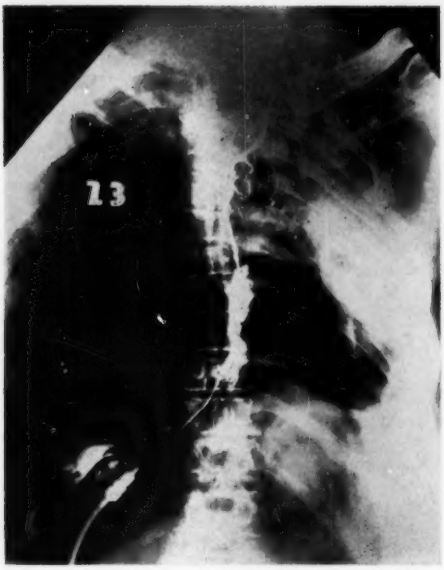


Fig. 8.—Thoracic ductogram. This injection was performed in a patient who died of metastatic malignancy. A radical neck dissection had been done on the left side several years previously. Note the extensive collateralization of lymphatics in the upper mediastinum and lower neck.

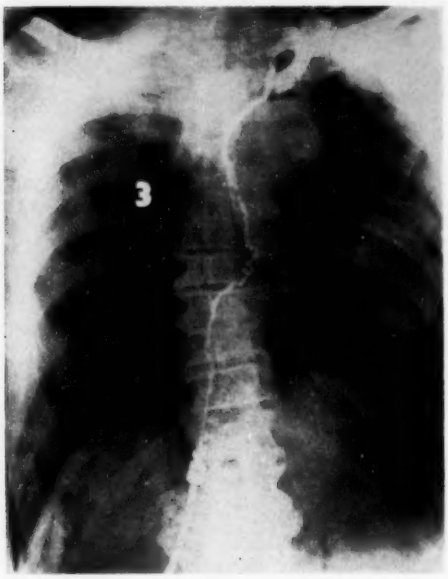


Fig. 9.—Thoracic ductogram. Autopsy findings in this patient included an aneurysm of the aortic arch. The upper portion of the thoracic duct has been displaced to the right by the tumor mass.

subclavian, and innominate veins were obstructed by clamps. After the injection of dye, x-rays were taken. The most interesting ductograms are presented in Figures 3 to 10.

Comment

General considerations of the anatomy, embryology, and physiology of the thoracic duct as well as the clinical aspects of chylothorax, have been reported and can be reviewed by the interested reader. The case herein reported presents the characteristic features of traumatic chylothorax—namely, the element of trauma followed by a latent period, respiratory embarrassment, and shock-like state, relieved by thoracentesis, with recurrence of symptoms following the reaccumulation of chyle in the chest. Ligation of the thoracic duct appears to have been a life-saving procedure in this instance. Evans-blue dye was helpful in outlining the thoracic duct and its collaterals.

Thoracic ductography has previously been reported by Lowman,[11] Stranahan,[12] and Celis [13] and their associates. The dye-contrast studies presented here emphasize the frequent variations in thoracic-duct patterns, departures not found in standard anatomy

Fig. 10.—Thoracic ductogram. Retrograde injection of the lower thoracic duct was performed. A true cysterna chyli is absent. A diffuse plexiform pattern is present instead.

textbooks. Collateralization offers one basis for the impunity with which the thoracic duct can be ligated, as was demonstrated in the experimental work of Lee[14] and Blalock and his associates.[15,16]

Summary

A patient with chylothorax complicating closure of an interventricular septal defect was successfully treated by ligation of the thoracic duct.

Thoracic ductograms are presented, demonstrating variants of the anatomy of the lymphatic system.

737 East 22d St. (4).

REFERENCES

1. Cruikshank, W.: Anatomy of the Absorbing Vessels of the Human Body, Ed. 2, London, G. Micol, 1790.

2. von Haller, A.: Disputationes anatomicae selectae, Gottingæ, A. Vandenhoeck, 1746-1752; cited by Cruikshank and Rouvière.

3. Lampson, R. S.: Traumatic Chylothorax, J. Thoracic Surg. 17:778, 1948.

4. Peet, M. M., and Campbell, K. N.: Massive Chylothorax Following Splanchnicectomy, Univ. Hosp. Bull., Ann Arbor, 9:2, 1943.

5. Cushing, H. W.: Operative Wounds of the Thoracic Duct: Report of Case with Suture of Duct, Ann. Surg. 27:719, 1898.

6. Yater, W. M.: Non-Traumatic Chylothorax and Chylopericardium: Review and Report of a Case Due to Carcinomatous Thromboangitis Obliterans of the Thoracic Duct and Upper Great Veins, Ann. Int. Med. 9:600, 1935.

7. Florer, R., and Ochsner, A.: Traumatic Chylothorax, Surgery 17:622, 1945.

8. DeWall, R. A.; Warden, H. E.; Read, R. C.; Gott, V. L.; Ziegler, N. R.; Varco, R. L., and Lillehei, C. W.: A Simple, Expendable, Artificial Oxygenator for Open Heart Surgery, S. Clin. North America 36:1025, 1956.

9. Melrose, D. G.; Dreyer, B.; Bertall, H. H., and Baker, J. B. E.: Elective Cardiac Arrest, Preliminary Communications, Lancet 2:21, 1955.

10. Merrill, K., Jr.: Use of Evans Blue to Outline the Course of the Thoracic Duct, J. Thoracic Surg. 29:555, 1955.

11. Lowman, R. M.; Hoogerhyde, J.; Waters, L. L., and Grant, C.: Traumatic Chylothorax: Roentgen Aspects of This Problem, Am. J. Roentgenol. 65:529, 1951.

12. Stranahan, A.; Alley, R. D.; Kansel, H. W., and Reeve, T. S.: Operative Thoracic Ductography, J. Thoracic Surg. 31:183, 1956.

13. Celis, A.; Kuthy, J., and del Castillo, E.: Importance of the Thoracic Duct in the Spread of Malignant Disease, Acta radiol. 45:169, 1956.

14. Lee, F.: Establishment of Collateral Circulation Following Ligation of the Thoracic Duct, Bull. Johns Hopkins Hosp. 33:21, 1922.

15. Blalock, A. R. S.; Cunningham, R. S., and Robinson, C. S.: Experimental Production of Chylothorax by Occlusion of the Superior Vena Cava, Ann. Surg. 104:359, 1936.

16. Blalock, A.; Robinson, C. S.; Cunningham, R. S., and Gray, M. E.: Experimental Studies on Lymphatic Blockage, Arch. Surg. 34:1049, 1937.

Hazards of Arteriography

P. H. KLINGENBERG, M.D., Dayton, Ohio

With the advent of replacement of diseased blood vessels with homografts, the surgical department at the Dayton Veterans' Administration Center Hospital has initiated frequent vascular visualization, using radiopaque dye within the lumen of the vessel. Although complications are infrequent, occasional serious sequelae, including death, may occur. From July, 1954, to October, 1956, the records of 47 patients undergoing aortography and 16 patients with peripheral arteriography have been reviewed, and three significant complications are reported. On the basis of these experiences, we approach arteriography with respect and insist upon proper indications for the surgical procedure.[1]

Review of Literature of Peripheral Arteriography

Peirce,[2] in 1951, described complications of percutaneous arterial catheterization: hemorrhage locally, hematoma formation; arteriovenous fistula; thrombosis of the femoral artery; arterial spasm; traumatic damage to the arterial wall; arterial rupture or dissection, and hypersensitive reaction to various dyes. In the same year Smith[3] described precautions to avoid: (1) too great a quantity of medium, (2) too great an injection pressure, and (3) too toxic and irritating a medium, which may cause end-artery spasm, with resulting ischemia and thrombosis.

Kleinsasser,[4] in 1947, reported the following occurrences. 1. Complications with sodium iodide: occurrence of gangrene of the feet with subsequent spread, (*a*) requiring amputation in one case and (*b*) resulting in death in one case. 2. Complications with iodopyracet (Diodrast). One death occurred, based on hypersensitivity following arteriography. 3. Spasm, severe pain, and diminished peripheral arterial pulsation. 4. Ulceration of digits following persistent absence of radial pulse, due to thrombosis. 5. Persistent bleeding, occurring once in 1000 cases, and abscesses, occurring two years after injection, noted by Dos Santoz[4] as rare complications.

In 1955 Julian and Dye[5] reported thrombosis of the femoral artery, producing ischemia and gangrene; femoral neuritis following extravasation of radiopaque material, and dislodgment of arteriosclerotic plaque.

Review of Cases

Among our cases we have observed the following complications: 1. Episode of acute renal failure (tubular necrosis) following rapid injection of concentrated dye into the aortic lumen, which had arteriosclerotic obstruction (Leriche syndrome) from a level below the renal vessels and including the bifurcation. Most of the dye entered directly into the renal arteries. Following a 10-day period of oliguria and acute uremia, renal tubular epithelium regenerated and the patient subsequently recovered completely. 2. Segmental gangrene of a portion of the thigh following femoral arteriography (case report below). 3. Cardiac arrest due to laryngospasm during thiopental (Pentothal) anesthesia, in which the patient had prolonged anoxia. This patient survived resuscitation with cardiac massage instituted in the x-ray department. We believe aortography can be done successfully with the use of local anesthesia in most cases. 4.

Submitted for publication April 29, 1957.

From the Veterans' Administration Center, Dayton, Ohio, and the Department of Surgery, Ohio State University College of Medicine, Columbus, Ohio.

Extravasation—this is ordinarily innocuous. 5. Thrombosis of the femoral artery. This patient had arteriosclerotic occlusion of the aorta and of both common iliac arteries. An arteriotomy and catheter injection of dye into the distal, pulseless, patent femoral artery was followed by thrombosis of the external iliac and femoral arteries extending from the arteriosclerotic occlusion in the common iliac artery to a level below the incision of the femoral artery. In future, arteriography should be done at the time of the major procedure as a preliminary investigation of outflow tract. 6. Nonfunctioning kidney. This patient had a large dose of dye injected into the right renal artery, and a temporary loss of function of this kidney (as shown by the intravenous pyelogram) occurred. Subsequent complete recovery occurred.

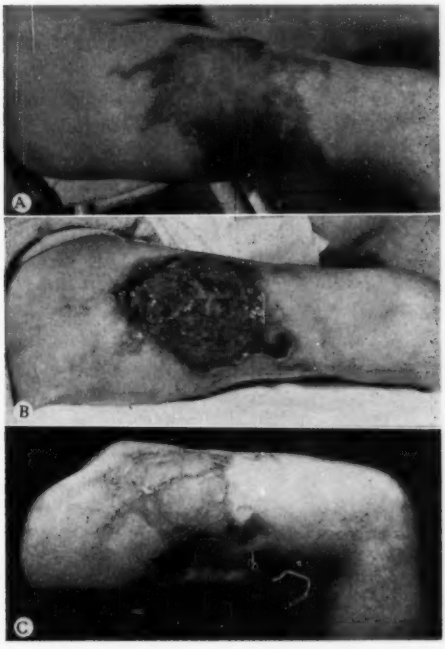
Report of a Case

The patient, 37 years old, was admitted to Veterans' Administration Center Hospital, Dayton, on Oct. 12, 1954. He had received a shrapnel injury in 1945, involving the right thigh and removing part of the right testis and all of the left testis. Several operations had been done in 1945 for wound infections of the right thigh. Pain was present in the right leg and right foot. Physical examination showed some atrophy of the right lower limb, with a deep stellate scar over the medial and posterior aspects of the right thigh. The right plantar reflex was absent; weakness of flexion of the right ankle and diminished cutaneous sensation over the right foot were noted. The right dorsalis pedis pulse was absent, but bilateral femoral, popliteal, and posterior tibial pulsations were felt.

Fig. 2.—Femoral arteriogram with extravasation.

On Nov. 5 a right femoral percutaneous arteriogram, using 30 cc. of 75% sodium acetrizoate (Urokon sodium) was completed, at which time extravasation of some of the dye occurred (Fig. 2). The patient had moderate thigh pain that day, but pulsations were unchanged. Cyanotic discoloration of the lateral aspect of the right thigh was apparent the next day (Fig. 1*A*). The skin of the thigh remained discolored but viable, and the patient was discharged on Nov. 25. However, he had to be readmitted on Dec. 28 because of gangrenous slough, and on Dec. 30, 1954, surgical débridement of necrotic skin and subcutaneous tissue was done (Fig. 1*B*). Subsequent skin grafting was successful (Fig. 1*C*).

Fig. 1.—*A*, gangrene following femoral arteriography; *B*, granulating base following excision of slough; *C*, healed skin graft.



Comment

In the review of this case, we have concluded that arterial spasm [6] in an extremity already deficient in blood supply through

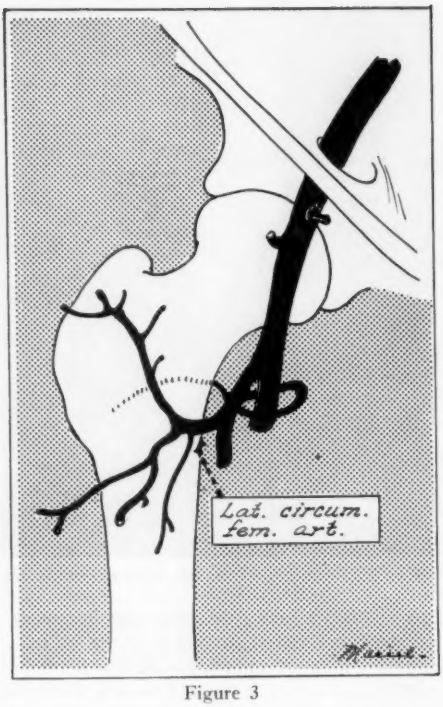


Figure 3

previous trauma and infection contributed significantly to the occurrence of gangrene. Extravasation was a second factor, but other cases have shown similar leak of dye into soft tissues without damaging effects. We consider the following points to be important.

1. The dye itself is an irritant to the intima, both chemically and as a foreign material. 2. Speed of injection and concentration of dye act as traumatic factors. 3. Size of lumen of vessel and distal obstruction by disease should be considered as important in determining quantity and concentration of dye used. 4. Vascular spasm occurs in all such procedures and, if severe and prolonged, may produce thrombosis and gangrene of portions of the body supplied by those vessels. In the case presented the arterial injection produced sufficient further local damage that the blood supply laterally was insufficient to maintain viability. The artery involved was the lateral circumflex femoral (Fig. 3).

Indications for Arteriography in Abdominal and Peripheral Arteries.—Inasmuch as injection of dye into arteries is not without danger, the following pathologic processes warrant arteriography: (1) occlusion, partial or complete, of large arteries by obliterative arteritis or embolism; (2) aneurysm or arteriovenous fistula; (3) adrenal or renal disease, including tumors and vascular abnormalities; (4) traumatic rupture of arteries; (5) placenta previa; (6) occasional large abdominal masses which cannot be delineated satisfactorily by other means; (7) rectal disease requiring radical surgery, in which vital collaterals supplying the lower extremity (already deficient in blood supply by peripheral vascular disease) may be sacrificed.

Arteriography should not be considered a routine practice but should be employed after simpler methods have not disclosed sufficient knowledge of the pathology. If adequate information is obtained from clinical and laboratory findings to make possible institution of specific therapy, arteriography is not done.

We have found arteriograms very useful in localizing the site and extent of arterial obstruction, in identifying true and false aneurysms and arteriovenous fistulas, and in the diagnosis of renal and adrenal tumors. When the above-mentioned indications are present, we have found arteriography a beneficial procedure with a calculated risk. When the indication is borderline or absent, we consider the danger inherent in the injection to exceed the knowledge to be obtained.

Summary

A case involving gangrene of the thigh following arteriography is described.

A review of the literature on complications of peripheral arteriography is presented.

Sixty cases of abdominal and lower-extremity arteriography are reviewed.

All visualization of arteries is to be done under calculated supervised technique, and only when surgical indications are present

and proper facilities are available to prevent, as well as treat, serious complications. Errors in technique or judgment were responsible for all complications reported.

Veterans' Administration Center, 4100 West Third St.

REFERENCES

1. Shumacker, H. B., Jr.: Use and Abuse of Diagnostic Aids, Surg. Gynec. & Obst. 100:112, 1955.

2. Peirce, E. C., II: Percutaneous Femoral Artery Catheterization in Man with Special Reference to Aortography, Surg. Gynec. & Obst. 93:56, 1951.

3. Smith, P. G.; Rush, T. W., and Evans, A. T.: An Evaluation of Translumbar Arteriography, J. Urol. 65:911, 1951.

4. Kleinsasser, L. J.: Peripheral Arteriography, Surgery 22:930, 1947.

5. Julian, O. C., and Dye, W. S.: Arteriography, S. Clin. North America 35:275, 1955.

6. Shaw, R. S.: Vascular Responses to Intra-Arterial Diodrast and Urokon During Arteriography, Surgery 39:385, 1956.

Use of Lyophilized Homografts of Dura Mater in Repair of Incisional Hernias

FRANCIS C. USHER, M.D., Houston, Texas

The use of patch grafts of cutis and of tantalum mesh for the repair of incisional hernias has become increasingly popular during the past 10 years, judging from the numerous reports in the literature.

The repair of those incisional hernias in which fascial aponeuroses can be imbricated without undue tension, according to the technique described by W. J. Mayo, is probably the best that can be obtained. Although originally designed for the repair of umbilical hernias, the principle of overlapping musculofascial layers can be applied to any incisional hernia, vertical or transverse, provided the tension is not too great. Enlarging the hernial defect by incising the hernial ring at both ends of its long axis often permits overlapping without too much tension. There is, however, a sizable minority of hernias in which primary closure cannot be done. It is this type of hernia that is best repaired with some type of patch or mesh.

Koontz [3,4] has had extensive experience with tantalum mesh and has published many reports concerning its use. Harkins [2] and others have reported good results with cutis grafts. From Germany have come many reports [1,7,8,11] on the successful use of nylon mesh. The few reports [5,9] in the American literature on the use of plastic fabrics have been discouraging because of the adverse effect of the prosthesis in the presence of infection.

Submitted for publication May 6, 1957.

From the Department of Surgery of the Baylor University College of Medicine and the Veterans' Administration Hospital.

My colleagues and I have been using lyophilized dura mater * since January, 1955, to repair incisional and inguinal hernias. Our experience with the use of this material for the repair of inguinal hernias has already been reported.[10]

Only those incisional hernias that were too large to allow closure by imbrication of the fascial layers were repaired with the lyophilized dura homografts. During this same two-year period, 35 incisional hernias were repaired by us, using the overlap technique described by W. J. Mayo, which we consider the method of choice when it can be done.

We have repaired a total of 15 incisional hernias with the dura, and sufficient time has now elapsed to permit evaluation of this technique. Eight of these incisional hernias were recurrent, and all were too large to permit primary closure by imbrication. The results are presented in the accompanying Table.

Dura mater is composed of two closely adherent layers of white fibrous tissue, identical with fascia lata, and possessing universal strength when strain is applied in any direction. Sheets of fascia lata have the disadvantage that the collagenous fibers are parallel and split easily. Dura mater can be obtained in slightly concave sheets of elliptical shape, measuring approximately 15×10 cm. This represents the portion covering a hemisphere of the cerebrum. We found that the material held silk and cotton sutures well, with no tendency to "cut through" the dura. The slight concavity of the graft was in no way objectionable. While

* Lyophilized dura mater may be obtained from Taylor Laboratories, Inc., Houston 4, Texas.

Analysis of Fifteen Cases of Incisional Hernias Repaired with Dura Mater

Case No.	Age	Sex	Date of Operation	Type of Hernia	Size of Graft	Result
1	43	F	12/18/54	Right rectus incision (cholecystectomy); defect 8×8 cm.	One hemisphere 10×10 cm.	No recurrence 2 yr. 4 mo. postoperative
2	70	M	1/17/55	Transverse incision (colostomy); defect 8×10 cm.	One hemisphere 10×15 cm.	Recurrence noted 1 yr. postoperative
3	56	M	2/16/55	Upper midline incision (gastrectomy); repaired once previously; defect 9.5×15 cm.	One hemisphere 10×15 cm.	No recurrence 2 yr. 2 mo. postoperative
4	44	F	2/25/55	Transverse lumbar incision (nephrectomy); repaired twice previously; defect 6×12 cm.	One hemisphere 10×15 cm.	Recurrence noted 1 yr. 10 mo. postoperative
5	52	F	2/17/55	Lower midline incision (exploratory); repaired twice previously; defect 10×30 cm.	Two hemispheres, each 10×15 cm.	No recurrence 2 yr. 2 mo. postoperative
6	43	F	3/3/55	Transverse lumbar incision (nephrectomy); defect 6×13 cm.	One hemisphere 10×15 cm.	No recurrence 2 yr. postoperative
7	56	M	4/27/55	Upper midline incision (gastrectomy); repaired once previously; defect 9×19 cm.	Two hemispheres, each 10×15 cm.	No recurrence 2 yr. postoperative
8	52	M	3/17/55	Right rectus incision (cholecystectomy); defect 5×20 cm.	Two hemispheres, each 10×15 cm.	No recurrence 2 yr. 1 mo. postoperative
9	45	M	8/18/55	Right rectus incision (exploratory); defect 8×8 cm.	One hemisphere 10×15 cm.	No recurrence 1 yr. 9 mo. postoperative
10	54	F	8/18/55	Lower midline incision (hysterectomy); repaired 3 times previously; defect 18×12 cm.	Two hemispheres, each 10×15 cm.	No recurrence 1 yr. 8 mo. postoperative
11	36	F	9/28/56	Upper midline incision (exploratory); defect 10×30 cm.	Two hemispheres, each 10×15 cm.	No recurrence 7 mo. postoperative
12	70	F	9/17/56	Upper midline incision (exploratory); defect 9×15 cm.	Two hemispheres, each 10×10 cm.	No recurrence 7 mo. postoperative
13	52	M	11/8/56	Lumbar hernia, traumatic; repaired 3 times previously; defect 12×6 cm.	One hemisphere 10×15 cm.	No recurrence 5 mo. postoperative
14	43	M	12/14/56	Transverse lumbar incision (bone graft, iliac crest); repaired once previously; defect 12×6 cm.	One hemisphere 10×15 cm.	No recurrence 4 mo. postoperative
15	40	F	3/10/57	Lumbar hernia, traumatic; repaired once previously; defect 10×8 cm.	One hemisphere 10×15 cm.	No recurrence 1 mo. postoperative

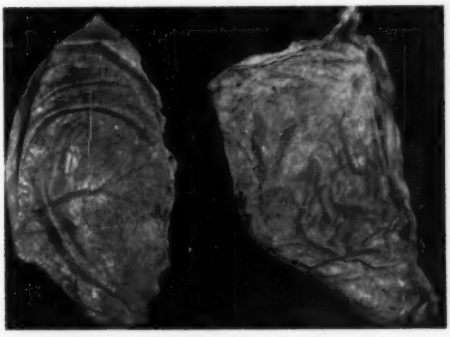


Fig. 1.—Left, fresh dura mater obtained at autopsy. Right, lyophilized dura mater which has been reconstituted. Each hemisphere measures about 10×15 cm.

a single graft was adequate in most ventral hernias, in the larger ones two grafts were placed side by side and sewn together. These homografts were preserved by freeze-drying (Fig. 1).

Technique of Hernia Repair

In repairing incisional hernias the hernial sac was dissected out, opened at its vertex, and split in its long axis to fashion two flaps. These peritoneal flaps were cleaned of fat and imbricated upon each other under slight tension in a manner similar to the Mayo technique of repairing umbilical hernias. No attempt was made to approximate the edges of the hernial ring. The anterior fascia (external oblique or rectus sheath) was then meticulously dissected free of fat for a distance of 4 cm. from the edges of the hernial ring on all sides. The reconstituted homograft of dura was then sewn to the exposed anterior fascia with two concentric rows of interrupted sutures of 00 cotton. The graft was "pie-crusted" to prevent accumulation of serum between the dura and the imbricated peritoneum beneath, and basting sutures were taken to obliterate any dead space between these two layers. Four No. 16 F. catheters with multiple fenestrations near the tip were then placed over the graft and led out through stab incisions in the four corners of the wound for suction drainage, as has been described by Koontz.[6] The catheters were joined by a series of Y-tubes and connected to a Stedman pump set for continuous suction at 5 cm. of water. A pressure dressing of mechanic's waste and elastoplast (elastic adhesive bandage) was then applied (Figs. 2 and 3).

The catheter-suction drainage has proved to be most effective in preventing serum accumulation in these wounds. Because of the extensive dissection and difficulty of obtaining complete hemostasis, seromas and hematomas are a potential complication in this type of hernia repair. Antibiotics were used postoperatively as a prophylactic measure in all cases. The wounds were carefully examined for seromas during the first two postoperative weeks and were aspirated daily when serum was found (Fig. 4).

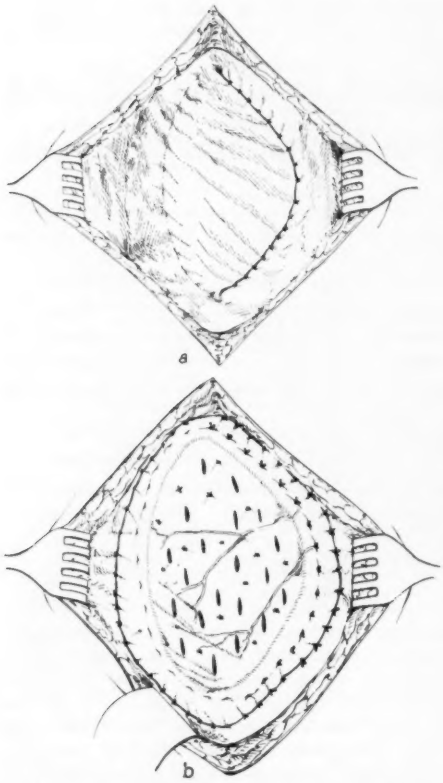


Fig. 2.—Technique of repairing incisional hernia with dura.

(*a*) The hernial sac has been opened and imbricated upon itself after dissecting it free of fat. (*b*) A hemisphere of dura has been sutured over the imbricated hernial sac. Note "pie-crusting" and basting stitches to prevent serum developing between the dura and the peritoneal surfaces.

Comment

During the past two years 15 incisional hernias have been repaired with lyophilized homografts of dura mater in this manner. There have been two recurrences to date. There were no wound infections. We have been able to follow up all 15 patients.

Biopsies in two recurrent hernias (inguinal) showed the graft to be replaced by white fibrous tissue, as shown in the photomicrography. This layer of fibrous tissue was pliant, strong, and two to three times the thickness of the original graft (Fig. 5).

Fig. 3.—Dura implant in place at operation. "Pie-crusting" incisions and basting stitches are not shown in this photograph.

Fig. 4.—Continuous suction drainage with Stedman pump. Suction drainage was used in all 15 cases.

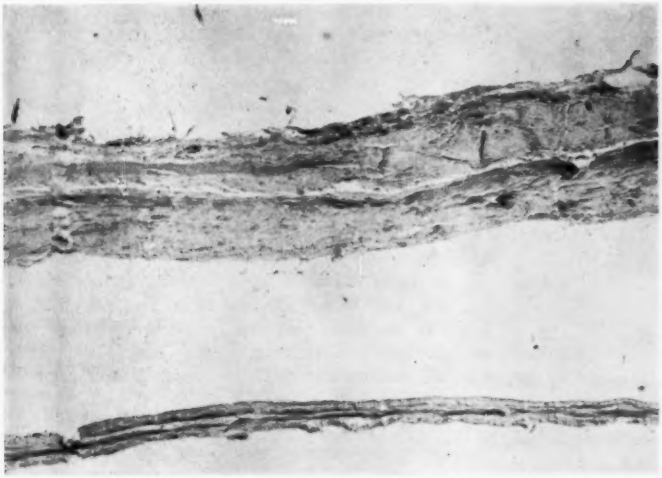


Fig. 5.—Photomicrograph (low power) of dura homograft eight months postoperative. The homograft has been partially replaced by white fibrous tissue from the host, but the original implant can be recognized in the middle of the specimen. Fresh dura below for comparison of thickness.

From our study of these patients, we know that the dura grafts will persist and their integrity be preserved for several months. During this time fibroplasia over and under the graft will take place, as in the case of cutis patch grafts and wire mesh. Our clinical observations on 15 cases in which we have used dura homografts bear out this statement.

Summary

A new material is described for the repair of large incisional hernias which would appear to fulfill all the requirements of a patch graft, with none of the disadvantages of those currently in use. Although more time will be necessary to evaluate the cases presented, the clinical course to date has been quite encouraging.

Baylor University College of Medicine.

REFERENCES

1. Aigner, E., and Scherz, F.: Hernienplastik mit Pehafilnetz, Wien. med. Wchnschr. 104:758, 1954.

2. Harkins, H. N.: Cutis Grafts: Clinical and Experimental Studies on Their Use as a Reinforcing Patch in the Repair of Large Ventral and Incisional Herniae, Ann. Surg. 122:996, 1945.

3. Koontz, A. R.: Tantalum Gauze in the Presence of Infection: Clinical Experience, Am. Surgeon 19:403, 1953.

4. Koontz, A. R.: Further Experiences with the Use of Tantalum Mesh in the Repair of Large Ventral Hernias, South M. J. 42:455, 1949.

5. Koontz, A. R., and Kimberly, R. C.: Evaluation of the Usefulness of Fortisan Fabric in Hernia Repair, Ann. Surg. 139:644, 1954.

6. Lattimore, T. J., and Koontz, A. R.: Suction Drainage After Implantation of Tantalum Gauze Sheets, J. A. M. A. 155:1333, 1954.

7. Rappert, E.: Der Verschluss grosser Hernien mit Pehafilnetzen, Klin. med. 8:279, 1953.

8. Sadek, J., and others: Die gegenseitige Beziehung von Gewcben and Polyamidharzen: 75 Hernioplastiken durch ein Polyamidnetz, Zentralbl. Chir. 78:1715, 1953.

9. Sanford, J. P.; Riley, P. A., and Sauvage, L. R.: Evaluation of Orlon Fabric in the Repair of Defects in the Abdominal Wall, Surgery 39: 236, 1956.

10. Usher, F. C.: Use of Lyophilized Homografts of Dura Mater in the Repair of Inguinal Hernias, Am. Surgeon 23:281, 1957.

11. Zuschneid, K.: Die operative Behandlung grosser Bauchdeckendefekte, Chirurg 25:461, 1954.

Bilateral Pheochromocytoma

RICHARD H. FLANDREAU, M.D., Philadelphia, and ARTHUR S. GLUSHIEN, M.D., Pittsburgh

It is of interest that the first reported case of pheochromocytoma, described by Fränkel [1] in 1886, had this tumor in both adrenal glands. Sixty years elapsed before the removal of bilateral adrenal chromaffin tumors was first reported, by Calkins and Howard [2] in 1947, and Colston [3] in 1948. The successful removal of bilateral pheochromocytomas in a single operation has, to our knowledge, been reported only by Roth and associates,[4] who in 1953 described three members of one family with bilateral tumors successfully treated. The following report describes a patient with bilateral pheochromocytomas which were removed in a one-stage operation. This case is of particular interest not only because of the unexpected findings which necessitated a decision during the operation to remove both adrenal glands in their entirety but also for the enormous quantities of vasopressor agents that were required to correct the profound shock that ensued.

Report of a Case

A 37-year-old white man was admitted to the Veterans' Administration Hospital, Pittsburgh, on Feb. 21, 1956, complaining of frequent headaches for one year and blurred vision. Examination revealed Grade III hypertensive changes in the ocular fundi, diminished visual acuity, slight cardiac enlargement, and arterial blood pressure of 200/150 mm. Hg. The urine consistently contained protein and casts, and at times erythrocytes and leukocytes. The urinary specific gravity ranged from 1.003 to 1.015. The maximum specific gravity during a concentration test was 1.021. Excretion of phenolsulfonphthalein was 57% in two hours, and the nonprotein nitrogen measured 72 mg. per 100 ml. Administration of 5 mg. of phentolamine hydrochloride U. S. P. (Regitine hydrochloride) intravenously on two occasions produced a fall of approximately 40 mm. Hg in both systolic and diastolic blood pressure. Neither test was considered positive, since the nonprotein nitrogen was elevated at the time of both tests and barbiturates had not been withheld prior to the first.

The patient was believed to have chronic glomerulonephritis with secondary hypertension and was treated with the Kempner rice diet and reserpine. After three weeks he developed postprandial epigastric pain and melena. A clinical and roentgenographic diagnosis of duodenal ulcer was made, and because of persistent hemorrhage laparotomy was considered imperative.

Review of the record immediately prior to the operation disclosed findings suggestive of pheochromocytoma, viz., repeated episodes of profuse perspiration, unexplained low-grade fever, hyperglycemia, glycosuria on one occasion, and variation of blood pressure between 140 and 260 mm. Hg systolic and 90 and 150 mm. Hg diastolic. Examination revealed both postural hypotension and postural tachycardia, the blood pressure falling from 240/140 to 170/120 mm. Hg and the pulse rate rising from 104 to 128 beats per minute when the patient changed from the recumbent to the erect position. In view of these findings, adrenal exploration was decided upon as the initial step in the operation, which, as has been noted, was primarily concerned with the management of the bleeding duodenal ulcer.

Laparotomy was performed, phentolamine being administered prior to induction of general anesthesia. Bilateral adrenal pheochromocytomas were encountered and excised. Both adrenal glands were so extensively involved by tumor as to require removal *in toto*, leaving no apparent adrenal tissue. The blood pressure fell slightly during the initial (right) adrenalectomy but dropped precipitously with the interruption of the left adrenal vein. Restoration of normotensive levels was temporarily effected by the intravenous administration of levarterenol bitartrate U. S. P. (Levophed bitartrate), phenylephrine hydrochloride (Neo-Synephrine hydrochloride), and hydrocortisone. An acute peptic ulcer of the posterior duodenal wall was simply oversewn through an

Submitted for publication April 4, 1957.

From the Departments of Surgery and Medicine, University of Pittsburgh School of Medicine, and the Veterans' Administration Hospital, Pittsburgh.

anterior duodenotomy. At the conclusion of the operation a polyethylene catheter was threaded into the inferior vena cava through the femoral vein.

Despite the administration of hydrocortisone, adrenal cortical extract, desoxycorticosterone acetate, and vasopressor agents in customary doses, the blood pressure was not maintained at satisfactory levels. The concentration of levarterenol and phenylephrine was gradually increased, until the patient was receiving these drugs undiluted. During the first 24 hours the patient received 212 mg. of levarterenol base, 2100 mg. of phenylephrine hydrochloride, and approximately 140 cc. of epinephrine hydrochloride. The blood pressure was maintained at approximately 100/80 mm. Hg. The temperature rose to 106.2 F and the pulse rate to 168 beats per minute. Urinary output totaled 185 ml. in 24 hours. At this time it was apparent that the administration of a large amount of sodium-free fluid, in the presence of oliguria, had led to water excess. The serum sodium measured 126 mEq/L. This dilution hyponatremia was readily corrected by administration of hypertonic saline solution. The use of steroids and vasopressor agents in large doses was continued. With this regime the urinary output became satisfactory; the temperature became normal; the pulse rate decreased to 116 beats per minute, and the blood pressure became stabilized at 140/100 mm. Hg. When the administration of vasopressors was discontinued 60 hours after operation, the patient had received 412 mg. of levarterenol base and 3460 mg. of phenylephrine hydrochloride.

Although the patient had developed some edema, there was subsequent excellent diuresis. The serum nonprotein nitrogen, which had risen to 119 mg. per 100 ml., slowly returned to normal. Postprandial epigastric pain recurred but responded to the institution of ulcer therapy. The dosage of steroids was tapered, and maintenance was effected with 37.5 mg. of cortisone and 25 mg. of methyltestosterone U. S. P. daily, together with 50 mg. of trimethylacetate desoxycorticosterone once a month. Recently this regime was discontinued and the patient maintained on fludrocortisone acetate 0.1 mg. with cortisone 12.5 mg. daily.

The patient has been followed for one year since operation. The serum nonprotein nitrogen has remained normal, and urinary specific gravities as high as 1.027 have been noted, although marked proteinuria has persisted. The blood pressure has averaged 155/110 mm. Hg. The hemorrhages in the ocular fundi have disappeared, but a few old exudates remain. Visual acuity has improved to the extent that the patient can read small type. There has been a 60 lb. (27 kg.) weight gain. The patient has experienced mild headaches occasionally, but not excessive perspiration. The abdominal complaints and melena have not recurred. Neither postural tachycardia nor postural hypotension is present. A dextrose tolerance test was normal, and a test with phentolamine did not produce a fall in blood pressure.

Fig. 1.—Cut surface of right adrenal gland with pheochromocytoma. A small rim of cortical tissue is noted on the left.

Pathologic Description.—Gross: The right adrenal gland measured 8×6×3 cm. and weighed 120 gm. The outer surface was covered by a pinkish-tan capsule. The cut surface revealed a neoplasm comprised of homogeneous tan, slightly convex, glistening tissue with small foci of hemorrhage, measuring up to 2 mm., scattered throughout. The tumor replaced normal adrenal structure except for a 2 mm. rim of golden-yellow cortical tissue (Fig. 1).

The left adrenal gland measured 5×3×2 cm. and weighed 40 gm. The cut surface revealed a neoplasm similar to that noted in the right. Two grams of normal-appearing adrenal tissue was present at one pole.

There was no gross evidence of capsular or vascular extension of either neoplasm.

Microscopic: Sections from both adrenals stained with hematoxylin and eosin after fixation in Zenker-glacial acetic fluid revealed a neoplasm formed by large polygonal and round epithelial-like cells arranged in groups. Cell nuclei were also large, ovoid to round, and vesicular, with distinct nucleoli and finely divided chromatin. For the most part the nuclei were uniform, although pleomorphic forms were also encountered. Mitoses were rare and of typical appearance. Cytoplasm of the tumor cells was abundant, acidophilic, and finely granular. However, in sections similarly stained after primary fixation in Müller's fluid, the cells were distinctly brown (positive chromaffin reaction). The borders of tumor cells were distinct, although on occasion such structure was imperceptible and cell groups appeared as syncytial masses. Neoplastic clusters were separated from

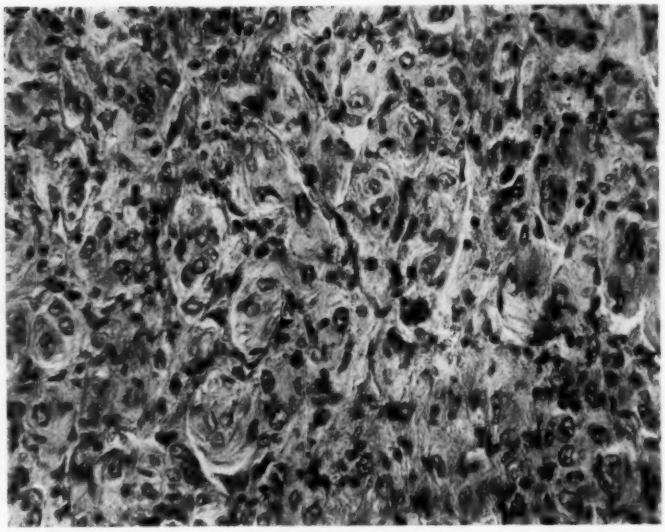


Fig. 2. — Photomicrograph showing clusters of large neoplastic cells. Reduced to 80% of mag. × 10.

neighboring groups by endothelial-lined channels and delicate strands of acellular connective tissue. The neoplasms appeared confined to the adrenal glands, and no evidence of capsular or vascular extension could be found in the many sections studied. In many areas normal-appearing cortical cells subtended the adrenal capsule, separating this structure from the neoplasm (Fig. 2).

Analysis: According to the colorimetric technique of von Euler and Hamberg,[5] the analysis for vasopressors revealed the right neoplasm to contain 7.3 mg. of epinephrine and 1.1 mg. of arterenol per gram of tumor. The left contained 4.7 mg. of epinephrine and 5.3 mg. of arterenol per gram of tumor.

Comment

The recognition of pheochromocytoma is of importance not only because the tumor produces one of the few curable forms of hypertension but also because any operative procedure or, indeed, the induction of anesthesia in a patient with this tumor may produce sudden death.[6,7] It is regrettable that, while considerable stress has been placed upon pharmacologic and other tests in the diagnosis of pheochromocytoma, the clinical findings suggestive of this tumor have received little mention. This patient showed excessive sweating, unexplained fever, postural tachycardia, postural hypotension, hyperglycemia, and, on one occasion, glycosuria. As Smithwick and associates [8] have pointed out, these findings should arouse suspicion of this lesion.

Since these tumors are estimated to be bilateral in 10% to 20% of cases, the finding of a pheochromocytoma in one adrenal gland necessitates exploration of the other, as well as all areas in the abdomen where chromaffin tissue is commonly located. The absence of a precipitous drop in blood pressure following the removal of the right adrenal pheochromocytoma from this patient indicated the presence of additional functioning chromaffin tumor tissue.

To our knowledge, this patient is the fourth from whom bilateral pheochromocytomas have been successfully removed in a single operation. The previous three instances were reported by Roth and associates.[4] In one of their patients it was not possible to preserve any normal adrenal cortical tissue; yet the postoperative course was uneventful. In contrast, our patient developed shock, which proved to be severe, prolonged, and almost refractory to treatment. Possibly the administration of steroids preoperatively might have prevented or mitigated the shock, but they had been withheld in view of the uncertainty as to the diagnosis of pheochromocytoma, the

lack of any suspicion that total bilateral adrenalectomy would be required, and our reluctance to administer steroids to a patient with bleeding peptic ulcer.

It seems unlikely that the use of phentolamine during the induction of anesthesia was responsible for the subsequent refractoriness to levarterenol, since the latter developed and persisted long after the effect of phentolamine should have disappeared. The patient was also refractory to phenylephrine, which is not antagonized by phentolamine. On the other hand, hyponatremia may well have contributed to the perpetuation of shock and tachyphylaxis, inasmuch as the pressor response to levarterenol and desoxycorticosterone depends upon the presence of an adequate amount of sodium in the body and is weakened or abolished during salt withdrawal.[9] Our patient responded much better to vasopressor agents after the hyponatremia had been corrected.

The amount of vasopressor medication administered to the patient was enormous. Beard and co-workers [10] described the case of an 11-year-old boy from whom a pheochromocytoma was removed, who died suddenly after having received 128 mg. of levarterenol in the course of 15 hours. Our patient received 212 mg. of levarterenol base and 2100 mg. of phenylephrine hydrochloride in the first 24 hours postoperatively, and a total of 412 and 3460 mg., respectively, in 60 hours, without toxic effects. Stated in other terms, over the period of 60 hours the patient was given an average of 115μg of levarterenol base and approximately 1 mg. of phenylephrine hydrochloride per minute, or approximately 40 times the concentration ordinarily employed of the former and 15 times that of the latter. The administration of these drugs in such quantities and concentrations would have been impossible had not a polyethylene catheter been inserted into the inferior vena cava.

The association of pheochromocytoma and massive gastrointestinal bleeding is rare. In a case reported by Gendel and Ende,[11] laparotomy and autopsy revealed no other apparent cause, and the hemorrhage was ascribed to the pheochromocytoma. However, the patient described by Tomsykoski and associates [12] had, in addition to a pheochromocytoma, a leiomyoma in the jejunum that accounted for melena. In our patient the bleeding was due to duodenal ulcer.

The persistence of hypertension following the removal of a pheochromocytoma is a common, but little understood, phenomenon.[13] The blood pressure in our patient, while not at a normal level, has remained much lower than it was prior to operation, and the regression of changes in the ocular fundi and the marked symptomatic improvement suggest that the prognosis has been greatly improved.

Summary

The case of a patient with bilateral adrenal pheochromocytoma treated successfully by one-stage total adrenalectomy is reported. The importance of the clinical findings suggestive of pheochromocytoma is emphasized. The etiology and treatment of an unusually refractory postexcision hypotension are discussed.

The case described in this report is believed to be the fourth instance of the successful removal of bilateral pheochromocytomas in a single operation.

The Winthrop Laboratories flew phenylephrine (Neo-Synephrine) from New York for this patient when the supply in Pittsburgh had been exhausted. The laboratory service of the Veterans' Administration Hospital, Dr. Edwin R. Fisher, Chief, performed the tumor analysis for vasopressors and supplied the pathologic description.

Misericordia Hospital, 54 St. & Cedar Ave., Philadelphia (Dr. Flandreau).

REFERENCES

1. Fränkel, F.: Ein Fall von doppelseitigem, völlig latent verlaufenen Nebennierentumor und gleichzeitiger Nephritis mit Veränderungen am Circulationsapparat und Retinitis, Virchows Arch. path. Anat. 103:244-263, 1886.

2. Calkins, E., and Howard, J. E.: Bilateral Familial Phaeochromocytomata with Paroxysmal Hypertension: Successful Surgical Removal of

Tumors in 2 Cases, with Discussion of Certain Diagnostic Procedures and Physiological Considerations, J. Clin. Endocrinol. 7:475-492, 1947.

3. Colston, J. A. C.: Surgical Aspects of Bilateral Familial Pheochromocytoma, J. Urol. 59: 1036-1060, 1948.

4. Roth, G. M.; Hightower, N. C., Jr.; Barker, N. W., and Priestley, J. T.: Familial Pheochromocytoma: Report on 3 Siblings with Bilateral Tumors, A. M. A. Arch. Surg. 67:100-109, 1953.

5. von Euler, U. S., and Hamberg, U.: Colorimetric Determination of Noradrenaline and Adrenaline, Acta physiol. scandinav. 19:74-84, 1949.

6. Apgar, V., and Papper, E. M.: Pheochromocytoma: Anesthetic Management During Surgical Treatment, A. M. A. Arch. Surg. 62:634-648, 1951.

7. Paulshock, B. Z., and Miller, E. R.: Unsuspected Pheochromocytoma Resulting in Postoperative Death, Ann. Int. Med. 44:573-575, 1956.

8. Smithwick, R. H.; Greer, W. E. R.; Robertson, C. W., and Wilkins, R. W.: Pheochromocytoma: A Discussion of Symptoms, Signs and Procedures of Diagnostic Value, New England J. Med. 242:252-257, 1950.

9. Raab, W.; Humphreys, R. J.; Makous, N., DeGrandpré, R., and Gigee, W.: Pressor Effects of Epinephrine, Norepinephrine and Desoxycorticosterone Acetate (DCA) Weakened by Sodium Withdrawal, Circulation 6:373-377, 1952.

10. Beard, E. F.; Butler, D. B., and Rosenberg, H. S.: Refractory Hypotension Following Removal of Pheochromocytoma, A. M. A. Arch. Int. Med. 96:273-276, 1955.

11. Gendel, B. R., and Ende, M.: Pheochromocytoma: Report of an Unusual Case with Gastro-Intestinal Bleeding, Gastroenterology 19:344-348, 1951.

12. Tomsykoski, A. J.; Stevens, R. C., and Brown, N.: Adrenal Pheochromocytoma and Leiomyoma of the Jejunum; Vascular Changes Associated with Pheochromocytoma, Am. J. Surg. 87:783-787, 1954.

13. Goldenberg, M.; Aranow, H., Jr.; Smith, A. A., and Faber, M.: Pheochromocytoma and Essential Hypertensive Vascular Disease, Arch. Int. Med. 86:823-836, 1950.

Influence of Infection on Homografts and Synthetic (Teflon) Grafts

A Comparative Study in Experimental Animals

J. HAROLD HARRISON, M.D., Atlanta

It is occasionally necessary to replace segments of blood vessels lost due to disease, trauma, or congenital abnormalities in infected or contaminated wounds. Though good results have been obtained with homografts and a variety of synthetic materials as vascular prostheses in sterile wounds, it is quite conceivable that the proteolytic enzymes of infection would digest a homograft, and it has been demonstrated that a close weave of a synthetic material prevents healing of infected wounds in other portions of the body.[1,5] The present report is based on a study in experimental animals undertaken to determine whether either graft is satisfactory, and, if so, which is preferable in the presence of contamination or infection.

Teflon (polytetrafluoroethylene) was chosen as the synthetic material because the results in a comparative series, including Dacron, nylon, Orlon, and Ivalon (polyvinyl formalinized) sponge, indicated that it was preferable for vascular prostheses, particularly when replacing segments of small blood vessels.[3] It has a high degree of chemical inertness, is practically nonwettable, and incites minimal tissue reaction.[2,4]

Materials

Homografts were obtained under sterile conditions, placed in glass tubes, and rapidly frozen in dry ice (solid carbon dioxide) and acetone at −70 C. They were then dehydrated in a vacuum at −40 C for 16 hours and at room temperature for 8 hours. The tubes were vacuum-sealed, and all grafts used were stored less than two weeks. The grafts were reconstituted in saline for 30 minutes and the branches ligated with 0000 nonabsorbable surgical (silk) sutures.

Woven tubes of Teflon 6 to 8 mm. in diameter were purified by boiling for 24 hours each in concentrated nitric acid and sulfuric acid. They were then rinsed copiously in saline to return the pH to neutral. Purification bleached the grafts white and caused some shrinkage. The ends were flamed over a Bunsen burner, making turning of cuffs unnecessary.

Methods

Adult mongrel dogs were used. All were anesthetized with intravenous pentobarbital sodium. Endotracheal tubes were inserted, and oxygen was given by intermittent positive pressure with a pneophore valve.

The abdomen was entered through a midline incision and the aorta freed from the renal arteries to the trifurcation. A 4 cm. segment of artery was excised and replaced by a graft of the same diameter and 5 cm. in length. Everting mattress sutures of 0000 arterial silk were placed at two corners and the anastomoses completed with a continuous over-and-over suture. The distal clamp was released, followed in one to three minutes, when all the bleeding had stopped, by a gradual release of the proximal clamp.

It was difficult to produce a standard degree of infection. Various concentrations and combinations of streptococci and staphylococci were tried unsuccessfully. After a number of trials it was found that 1 cc. of a 10% solution of the animal's own feces strained through two layers of surgical gauze would produce in 80% to 90% of the animals localized abscesses containing from 15 to 30 cc. of purulent material.

The studies were divided into two groups.

GROUP I: *Infected Wounds.*—Twenty animals were followed. A small incision was made in the left flank, and 1 cc. of the feces solution was injected into the retroperitoneal tissue around the aorta below the level of the renal arteries. Forty-

Submitted for publication May 6, 1957.

From the Research and Development Service, Fitzsimons Army Hospital, Denver.

eight hours later the abdomen was opened and the abscess drained. The graft was then inserted into the abscess bed. Neomycin sulfate, 1 gm., and oxytetracycline U. S. P. (Terramycin), 125 mg., in 20 cc. of saline were introduced locally and the retroperitoneal area left open.

Twenty-four hours following contamination the animals were started on 600,000 units of procaine penicillin G U. S. P. and 1 gm. of streptomycin, which was given daily for three weeks, and longer if fever persisted. Rectal temperatures were taken twice daily as long as they were elevated, and then weekly until the time the animals were killed.

GROUP II: *Contaminated Wounds.*—Twenty-one animals were followed. The abdomens were shaved and prepped, and grafts were inserted under sterile conditions. The peritoneum was closed tightly over the graft with an interrupted suture of 0000 silk. The feces solution was then injected through an 18-gauge needle into the retroperitoneal area around the graft, care being taken to prevent peritoneal contamination.

Twenty-four hours after surgery the animals were started on penicillin and streptomycin. These were continued and temperatures taken as in the Group I series. After four to nine days, if the animals were febrile, an incision was made in the left flank, with local anesthesia, and the area of the graft drained. A Penrose drain was inserted and left for seven days.

All animals were followed for evidence of systemic infection and changes in pulse. They were then killed, at intervals of up to four months. Prior to being killed, they were anesthetized and the region of the grafts explored to evaluate the blood flow. All grafts were excised and studied grossly and histologically. Sections of the homografts were stained with hematoxylin and eosin and Gomori's elastic-tissue technique.

A series of 19 purified Teflon grafts and 10 homografts inserted in sterile wounds were used as controls.[2]

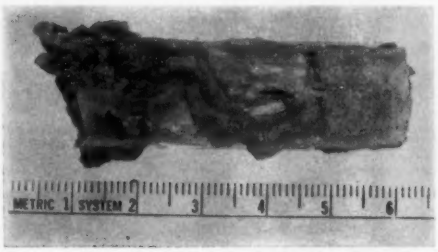


Fig. 1.—Homograft in infected wound—six days. Animal exsanguinated from rupture through central portion of graft (arrow points to site of rupture). U. S. Army Photograph.

Results

GROUP I: *Infected Wounds.*—Abscesses containing 15 to 30 cc. of purulent material were produced in most instances. In some cases there was a generalized peritonitis and in others only marked edema at the site of injection.

Homografts: Eleven animals with homografts inserted into the bed of the drained abscess were followed. Early complications of the graft resulting from the infection developed in five and were fatal in all. These were due to rupture of the grafts with exsanguination in three animals, at 3, 7, and 19 days, respectively, and to occlusion by thrombosis in two others, at 8 and 12 days postoperatively (Fig. 1). The infection resolved in the remaining six animals. Four of these had abscesses at the time of the insertion, while the other two had only marked edema. In one of these, examined at three months,

Summary of Results with Homografts and Teflon Grafts in Infected and Contaminated Wounds

	Group I Infected Wounds				Group II Contaminated Wounds				Totals in Infected and Contaminated Wounds			
	Teflon Grafts		Homografts		Teflon Grafts		Homografts		Teflon Grafts		Homografts	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No. of animals followed	10	100	11	100	11	100	9	100	21	100	20	100
Total complications resulting from infection	5	50.0	5	45.5	7	63.6	6	66.7	12	57.1	11	55.6
Fatal complications	3	30.0	5	45.5	3	27.3	5	55.6	6	28.6	10	50.0
Death from peritonitis, grafts patent	0	0.0	0	0.0	2	18.2	0	0.0	2	9.5	0	0.0
Rupture of grafts with exsanguination	2	20.0	3	27.3	0	0.0	3	33.3	2	9.5	6	30.0
Infection with occlusion of grafts												
Causing death	1	10.0	2	18.2	1	9.1	2	22.2	2	9.5	4	20.0
Not fatal	2	20.0	0	0.0	4	36.4	1	11.1	6	28.6	1	10.0
Resolution of infection	5	50.0	6	55.6	4	36.4	3	33.3	9	42.9	9	45.0
Late thrombosis after infection resolved	1	10.0	0	0.0	1	9.1	0	0.0	2	9.5	0	0.0

Fig. 2.—Teflon graft in infected wound—nine weeks. All infection had resolved. A thick layer of fibrin lines inner surface and dense fibrous tissue surrounds outer surface of graft. Contraction of fibrous tissue during healing caused wrinkling of graft. This, in conjunction with the fibrin lining, caused occlusion at 48 days. U. S. Army Photograph.

there was a thinned area with a slight bulge in the distal half of the graft (Table).

Teflon Grafts: Ten animals were followed. Complications of infection developed in five and were fatal in three (Table). Two exsanguinated from separation of the graft at the suture line at five and seven days postoperatively. Another died at 15 days with a large retroperitoneal abscess in which the graft was occluded. Two animals, killed at 34 and 120 days respectively, had small localized abscesses surrounding grafts that were occluded by thrombosis. The infection resolved in five. In three of these there were thicker fibrin linings of the inner and fibrous enclosures of the outer surface than was noted with similar grafts in the control series in sterile wounds. Contraction of the thick fibrous enclosures during healing caused buckling and occlusion of one of the grafts at 48 days after the infection had resolved (Fig. 2).

Group II: *Contaminated Wounds.*—Evaluation of the extent of infection was more difficult in these animals than in Group I. It could be determined directly by observation at the time of drainage and at autopsy when the complications proved fatal, or indirectly by following the temperature curves.

Homografts: Nine animals were followed. There were complications of the grafts from infection in six, which proved fatal in five (Table). Three died of exsanguination after rupture of the grafts at 5, 7, and 17

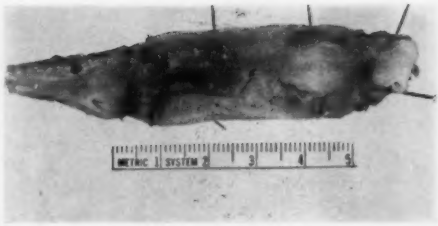


Fig. 3.—Teflon graft in contaminated wound—seven days. Animal died of generalized peritonitis. Graft was functioning well. Note shaggy appearance of inner lining. U. S. Army Photograph.

days postoperatively. Two others died of abscess and thrombosis of the graft at five and six days. One animal, killed at 42 days, had a localized abscess in which the graft had undergone practically complete lysis. There was resolution of the infection with healing in three. In two of these, the extent of infection was questionable, as the animals had no temperature elevations after the second postoperative day.

Teflon Grafts: Eleven animals were followed. Complications from abscess or peritonitis developed in seven, resulting in death in three (Table). Two died of generalized peritonitis at five and nine days postoperatively. In these the grafts had shaggy inner linings but were intact and patent (Fig. 3). One animal died at eight days of a large retroperitoneal abscess in which the graft was occluded. Four others, killed at 16, 19, 22, and 23 days postoperatively, had small, well-localized abcesses. The grafts had become occluded by thrombosis, and three were partially separated from the host vessel at the suture lines. The separation was complicated by a hematoma in one, but occlusion of the proximal and distal arteries prevented bleeding in the others. The infection resolved in four animals. In two of these there was marked edema but no abscess was detected at the time of drainage, on the ninth postoperative day. All, however, had temperature elevations up to 104 F for two weeks, which later returned to normal, indicating that infection had developed and resolved. Three of the four had thick fibrin linings and fibrous enclosures, similar to the ones in Group I. Contraction of the fibrous

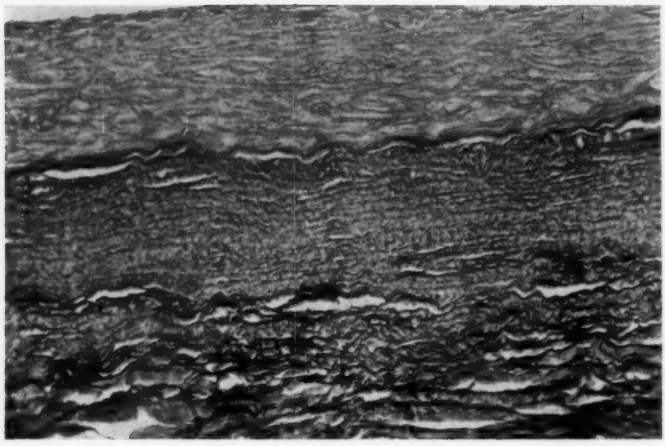


Fig. 4. — Photomicrographs of walls of homografts in sterile and infected wounds stained with Gomori's elastic-stain method.

Fig. 4A.—Sterile wound, 60 days; elastic fibers are intact.

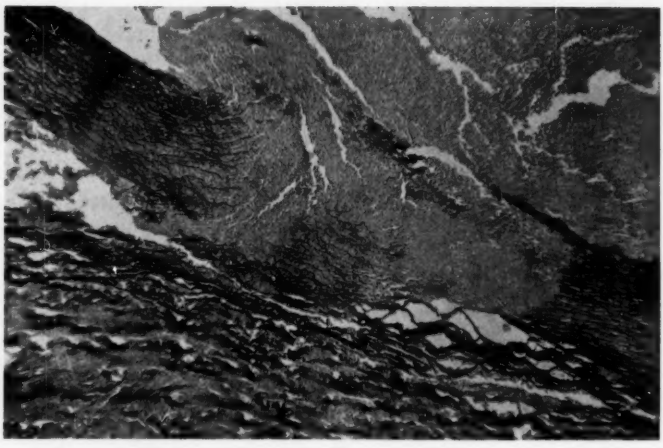


Fig. 4B.—Infected wound, six days. There is abscess with complete disruption of wall of graft.

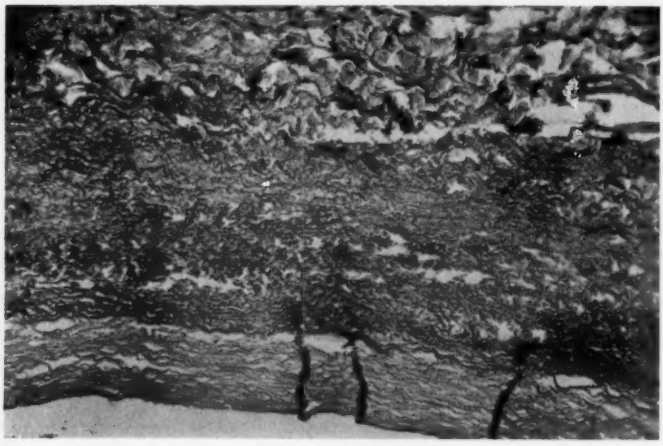


Fig. 4C.—Infected wound, 90 days. Infection had resolved, and graft was functioning well at time of killing. Note disruption of elastic fibers in media, as compared with Fig. 4A.

tissue was responsible for wrinkling with occlusion of one of the grafts at 30 days. The remainder remained patent.

Rupture of most of the homografts occurred at the suture lines from breakdown of the graft, allowing the sutures to pull out. In others, it occurred in the central portion not adjacent to branches that had been ligated. In none did the sutures pull out of the host artery. Histologically, there was a marked inflammatory reaction in the walls of the homografts with destruction of all layers (Fig. 4B). In some of the homografts examined at later dates, when the infection had resolved, there were areas of disruption of the elastic fibers of the media (Fig. 4C).

Bleeding in the animals with Teflon grafts was due to separation at the suture lines, resulting from the sutures pulling through the degenerated host artery. There was no bleeding through the interstices of the grafts themselves.

Comment

The results with both homografts and Teflon grafts were better in the Group I animals, in which the grafts were placed in the bed of a drained abscess, than in Group II, where the wounds were contaminated at the time of insertion. This difference may be attributed partially to the use of local antibiotics in Group I but is felt to be due primarily to the better drainage afforded by leaving the abscess open. The retroperitoneal area closed when the wound was contaminated at the time of grafting, and, though drainage through a flank incision was performed, it is almost impossible to maintain adequate drainage of this area in a dog. Adequate drainage and control of infection are imperative, as none of the homografts or Teflon grafts were successful otherwise.

The over-all incidence of complications of infection with the Teflon grafts and homografts was similar, occurring in 57% and 55%, respectively. The number of fatal complications and the mode of death were, however, significantly different (Fig. 5).

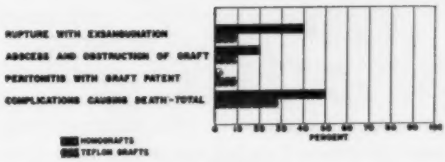


Fig. 5.—Incidence and cause of fatal complications with homografts and Teflon grafts in infected wounds.

Complications led to death in 50% of the animals in which homografts were inserted. In 30% death followed exsanguination from rupture of the graft walls and 20% from abcesses and thrombosis. Twenty-nine per cent of the animals with Teflon grafts died. Rupture with exsanguination occurred in only 9.5%. Death in the others was due primarily to peritonitis, the grafts being intact and functioning in 9.5% and occluded in 9.5% (Fig. 5). Excluding the animals dying of peritonitis with the grafts patent, the incidence of fatal complications attributed primarily to the Teflon grafts is reduced to 19%, which is considerably lower than the 50% with homografts.

The proteolytic enzymes of infection cause deterioration of the walls of homografts. If this is extensive enough, it will result in rupture with exsanguination. Less degrees will weaken the wall of the graft by interrupting its elastic fibers to the extent that later complications of aneurysm or rupture may be expected. Longer follow-up study is necessary to determine this point.

The only source of bleeding with the Teflon grafts is separation at the suture line from a breakdown of the host vessel, allowing the sutures to pull out. Since the normal blood vessel is more resistant to infection than a homograft, separation should, and did, not occur as frequently with the Teflon grafts. Fatal complications from the Teflon grafts are due primarily to peritonitis with or without occlusion. These complications are more amenable to therapy by control of the infection. Late complications of aneurysm or rupture of the Teflon grafts would not be expected, as the material is resistant to the inflammatory enzymes.

The rate of occlusion of the Teflon grafts was higher than that of the homografts, occurring in 48% and 25%, respectively. These figures are somewhat misleading, as part of the homografts that ruptured were also thrombosed and others would have done so had they not ruptured first. Excluding the grafts of both that ruptured, there was thrombosis of 58% of the Teflon grafts and 43% of the homografts (Table).

The incidence of occlusion of Teflon grafts less than 9 mm. in diameter will be higher when the graft is placed in infected wounds than when placed in sterile wounds even if the infection resolves, particularly when an abscess is present for any length of time. An abscess wall forms a thicker fibrous enclosure around the graft, and the lowered vascularity in the abscess cavity causes a thicker fibrin lining of the inner surface and a delay in healing. As the infection resolves and healing progresses, contraction of this dense fibrous tissue surrounding the graft may produce buckling. If this occurs while the fibrin lining the inner surface is still present, the rate of occlusion from thrombosis will be increased. This was evidenced by occlusion in two of the grafts in this series after the infection had resolved (Table). If vessels larger than this are replaced, this complication should not occur.

Though both the Teflon graft and the homograft are foreign bodies, the results indicate that they will allow wound healing in the presence of infection provided other complications do not occur. The rate of healing was essentially the same in the two, occurring in 45% of the homografts and in 43% of the Teflon grafts. Should the cases with homografts that were only questionably infected be excluded, results would not be as good as with the Teflon grafts. This could be done in the two cases in the infected group with only edema present when the graft was inserted but probably should not in the contaminated group, as it is possible that infection is less likely to develop in the presence of a homograft. The inability to produce a consistent degree of infection precludes an accurate evaluation of this factor.

The results indicate that, though either graft leaves much to be desired, a Teflon graft is preferable to a homograft in the presence of infection or contamination. The early complications encountered are less apt to prove fatal and are more amenable to therapy. Late complications from breakdown that might be expected with homografts should not occur with Teflon.

Better results should be expected in their clinical application. The extent of infection produced in these animals will not usually be encountered, and in the human it can be better controlled, as better drainage can be obtained and more specific antibiotics given.

The presence of contamination or infection should not contraindicate grafting. If it is to be done, however, particular care should be given to the avoidance of too extensive dissection of the host vessels and to taking healthy bites in performing the anastomoses. The proper antibiotics should be given, and early adequate drainage should be instituted to control the infection, as no graft will be satisfactory otherwise.

Summary

Frozen, dried homografts and woven, purified Teflon tubes were inserted as vascular prostheses in infected and contaminated wounds in 41 dogs.

Complications of the infections developed in 55% of the homografts and in 57% of the Teflon grafts. The significant difference in the two was the incidence of fatal complications and the mode of death. Fifty per cent of the animals with homografts died primarily as a result of exsanguination from rupture of the grafts. Complications with Teflon grafts were due primarily to peritonitis with or without occlusion of the grafts. Twenty-nine percent of the animals died, death being attributable directly to the grafts in only 19%

The proteolytic enzymes of infection cause deterioration of the walls of a homograft.

If extensive, this leads to rupture in the early stages. Less degrees cause breakdown of the elastic fibers in the walls, which might lead to aneurysm or rupture at a later date. Bleeding with the Teflon grafts is due only to separation at the suture lines from degeneration of the host artery and pulling out of the sutures.

The rate of occlusion of Teflon grafts was higher than with homografts, occurring in 48% and 25%, respectively.

The results indicate that either will allow resolution of infection provided other complications do not ensue. Wound healing occurred with 45% of the homografts and with 43% of the Teflon grafts.

Though both grafts leave much to be desired, the results in this study indicate that Teflon grafts are superior to homografts. The complications encountered are more amenable to therapy and less likely to cause death. Late complications of breakdown that might be expected with the homografts should not occur with Teflon.

Early drainage and control of infection are imperative if good results are to be obtained with either graft.

Department of Surgery, Emory University School of Medicine.

REFERENCES

1. Harrison, J. H.: A Teflon Weave for Replacing Tissue Defects, Surg. Gynec. & Obst. 104: 584, 1957.

2. Harrison, J. H.: The Use of Teflon as a Blood Vessel Replacement in Experimental Animals, Surg. Gynec. & Obst. 104:81, 1957.

3. Harrison, J. H.: Synthetic Materials as Vascular Prostheses: I. A Comparative Study in Small Vessels of Nylon, Dacron, Orlon, Ivalon, Sponge and Teflon, to be published.

4. Harrison, J. H.; Swanson, D. S., and Lincoln, A. F.: A Comparison of the Tissue Reactions to Plastic Materials: Dacron, Ivalon Sponge, Nylon, Orlon and Teflon, A. M. A. Arch. Surg. 74:139, 1957.

5. Sanford, J. P.; Riley, P. A., and Sauvage, L. R.: Evaluation of Orlon Fabric in the Repair of Defects in the Abdominal Wall, Surgery 39: 237, 1956.

Subtotal Gastric Resection for Benign Peptic Ulcer

A Follow-Up Study of Three Hundred Fifty-Three Patients

NEWLIN HASTINGS, M.D.; JAMES A. HALSTED, M.D.; EDWARD R. WOODWARD, M.D.; MARVIN GASSTER, M.D., and ELVA A. HISCOCK, B.S., Los Angeles

Benign peptic ulcer is a disease which afflicts over one-half million people and causes about 10,000 deaths each year in the United States.[1,2] It is frequently refractory to medical management and often is incompletely alleviated by surgical therapy. The lack of satisfaction in operative measures is partly reflected in the variety of procedures employed. Since its introduction by Péan,[3] Rydygier,[4] and Billroth[5] (1879-1881), distal partial gastrectomy has been developed into the operation most commonly used today.[6-10] Various types of pyloroplasty and gastrojejunostomy were employed in the late 19th century, but as single procedures they have largely been discarded in the last 25 years because of the prohibitively high rate of recurrent ulceration. With the recognition of the important role of the vagus nerve in the excessive gastric secretion of duodenal ulcer patients, Dragstedt introduced vagotomy.[11] Although unsuccessful as a single procedure, it has been satisfactorily combined with the drainage operations, pyloroplasty, and gastrojejunostomy. Elucidation of the hormonal function of the gastric antrum in the past 10 years has lead to recent use of vagotomy combined with antrectomy by several groups of surgeons.[12,13,16-18]

The morbidity and mortality associated with each of the above procedures are well documented.[14-28] Each type of surgical therapy has yielded initial success, but adequate evaluation of the long-term results from treatment of such a complex chronic disease as peptic ulcer can be made only after a prolonged period of observation. In 1950 a program was established at the Wadsworth Hospital, Veterans' Administration Center, to investigate the results of various methods of treatment for peptic ulcer. The present report is a study of patients who were treated by subtotal gastric resection in the years 1947 through 1954. During this eight-year period more than 6000 patients were discharged with a final diagnosis of benign peptic ulcer. The clinical diagnoses in these cases were as follows: duodenal ulcer, 4816; gastric ulcer, 1032; site unspecified, 303, a total of 6151.

Of this large group, the most serious cases were evaluated jointly by members of the medical and surgical departments. After consultation, often in a formal weekly medical-surgical gastrointestinal conference, 1642 patients received surgical treatment as follows:

Subtotal gastric resection	1048
Vagus resection with ancillary procedures	256
Gastrojejunostomy	48
Closure of perforation	276
Pyloroplasty	14
	1642

In studying the long-term results of subtotal gastric resection of benign peptic ulcer, all patients who had had this operation during the eight-year period were requested to report for follow-up examination, provided the operation had been performed at least one year prior to such examination.

Submitted for publication March 28, 1957.

This work was aided in part by U. S. Public Health Service Grant No. RG-4195.

From the Wadsworth General Medical and Surgical Hospital, Veterans' Administration Center, and the Departments of Surgery and Medicine, University of California Medical Center, Los Angeles.

Three hundred fifty-three patients, or 34% of the total number of patients who had this type of surgical procedure, were seen. This represents a 46% follow-up after correction for patients who could not be communicated with or who had died during the follow-up period. The patients were interviewed in the gastrointestinal clinic by two attending specialists in gastroenterology and general surgery. A dietitian attached to the clinic interviewed many of the patients in whom there was evidence of malnutrition. Clinical data obtained from the hospital charts were recorded on a mimeographed form. After careful analysis, each patient was classified clinically according to rigid criteria and rated as excellent, good, fair, poor, or failure:

Excellent: Patient completely free of gastrointestinal complaints, maintaining normal body weight, and continuing usual vocational and social activities

Good: Patient completely free of ulcer symptoms but having mild gastrointestinal complaints controlled completely by simple dietary means

Fair: Patient free of ulcer symptoms but with gastrointestinal complaints controlled incompletely by diet and/or simple medication, but not interfering with normal activities

Poor: Patient free of ulcer disease but incapacitated to a significant degree by gastrointestinal symptoms or malnutrition

Failure: Patient with presumptive or conclusive evidence of recurrent peptic ulceration.

Although the patient's opinion of the surgical result was elicited, the physicians' classification was uninfluenced by it, and not infrequently no correlation could be made between the doctors' classification and the patient's opinion.

Of the 353 patients used in this study, 240 had duodenal ulcer and 13 had gastrojejunal ulcer following gastrojejunostomy. The latter group is combined with those having duodenal ulcer, since the surgical problem they present is so similar and basal hypersecretion of gastric juice is present in both. One hundred patients had benign gastric ulcer, and of these, twenty-two had a history of duodenal ulcer as well; however, the major problem leading to and encountered at surgery was a gastric ulcer.

TABLE 1.—*Age Distribution*

Age, Yr.	Duodenal Ulcer (233 Patients)	Gastric Ulcer (96 Patients)
To 39	18%	8%
40–49	19%	14%
50–59	40%	45%
60–69	20%	26%
70 and over	3%	7%

Since the Veteran population is predominantly male, there were only two female patients in this series. The ages of the patients varied from 24 to 77 years; the average age of the duodenal ulcer patients was 50 years, whereas that of the gastric ulcer patients was 55 years (Table 1). In the duodenal ulcer group 37% were under 50 years of age, whereas in the gastric ulcer group 22% were less than 50 years old.

The duration of symptoms is listed in Table 2. The shortest history of gastric ulcer was 10 days and the longest 39 years. Of the duodenal ulcer patients 74% had symptoms for more than five years, whereas only 48% of those with gastric ulcer had symptoms for more than five years.

A serious complication of peptic ulcer had occurred in 94% of the 353 patients. Multiple complications occurred in many, as is shown in Table 3. The incidence of a given complication was almost twice as high in the duodenal ulcer group as in the gastric ulcer group. One or more complications were considered to indicate surgical intervention.

Over one-half of the 253 duodenal ulcer patients had hemorrhage as the primary indication. Emergency surgery for massive bleeding was performed in 36 of these cases. Intractable pain, despite medical

TABLE 2.—*Duration of Symptoms*

Duration, Yr.	Duodenal Ulcer (242 Patients)	Gastric Ulcer (85 Patients)
1 or less	10%	26%
2–5	16%	25%
6–9	29%	14%
10 or more	45%	35%

TABLE 3.—*Complications*

	Duodenal and Marginal Ulcer (253 Patients)	Gastric Ulcer (100 Patients)
Hemorrhage	72%	38%
Perforation	25%	12%
Obstruction	21%	9%
Gastrojejunocolic fistula	1%	

therapy, was often a factor in the decision for elective surgery and was considered the primary indication in 30% of the duodenal ulcer patients. In gastric ulcer failure in healing after a reasonable period of intensive medical therapy was considered indication for gastric resection because of the possibility of malignancy. This was the primary indication in 55% of the gastric ulcer group. These cases in which malignancy was found were not included in this study.

The Hofmeister or Polya type of Billroth II gastric resection was employed in most cases; only 7 patients in the duodenal ulcer group and 15 in the gastric ulcer group had a gastroduodenostomy. The amount of stomach resected was estimated by the surgeon and is summarized in Table 4.

The follow-up period varied from 1 to 7 years, with an average of 2.4 years in the duodenal ulcer group and 2.6 years in the gastric ulcer group.

Each patient was questioned as to his satisfaction with the final result. The opinions are presented in Table 5. Six patients with recurrent peptic ulceration expressed satisfaction with their clinical results.

Using the criteria presented in the tabulation, the patients were classified by the reviewing physicians, as presented in Table 6. The results are comparable in the duodenal and the gastric ulcer group except in the Failure category. The incidence of

TABLE 4.—*Extent of Gastric Resection*

Stomach Resected	Duodenal Ulcer Patients	Gastric Ulcer Patients
Less than 60%	5%	8%
60%–70%	61%	58%
Over 70%	34%	25%
Not stated		9%

TABLE 5.—*Patients' Opinion of Result*

	Duodenal Ulcer (246 Patients)	Gastric Ulcer (100 Patients)
Satisfied	83%	90%
Dissatisfied	11%	3%
Uncertain	6%	7%

recurrent ulceration was 9% in the patients with duodenal ulcer. The only failure in the gastric ulcer group was in a patient who also had a duodenal ulcer. The 24 patients with recurrent ulceration did not differ from the entire group in age or in the extent of gastric resection performed. Likewise, the indications for surgery were no different with the exception of obstruction. No patient operated upon because of this complication had a recurrence.

Since this report is merely an attempt to evaluate, as objectively as possible, the results which may be expected after gastric resection for peptic ulcer in terms of how many cases are likely to have unsatisfactory results, a detailed discussion of gastric symptomatology, the dumping syndrome, and nutritional problems, which go to make up the unsatisfactory state, is not considered worth while. These factors have been thoroughly discussed in the literature, and our experience is similar to other published reports. However, we have been interested in the matter of inability to gain weight after the operation. In interviewing the patients and studying their records, particular care was taken to ascertain, as accurately as possible, the patient's average normal weight before operation and before unusual symptoms, such as obstruction, might contribute to weight loss. This weight was compared with the observed weight at follow-up examination and the patient's statement as to his usual weight since the operation. Table 7 shows the results of

TABLE 6.—*Physicians' Evaluation of Results*

	Duodenal Ulcer (253 Patients)	Gastric Ulcer (100 Patients)
Excellent	42%	44%
Good	26%	34%
Fair	15%	14%
Poor	8%	7%
Failure	9%	1%

TABLE 7.—*Body Weight One Year or More After Gastric Resection*

Group	Total	Lost Weight *		Gained Weight *		No Change	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
Satisfactory (excellent and good results)	223	72	32	74	33	77	35
Unsatisfactory (fair and poor results)	78	43	55	12	15	23	30
Total	301	115	38	86	29	100	33

* The criteria are a gain or loss of 5 lb. or more over average normal preoperative weight.

this study; the data were based on 301 cases of both duodenal and gastric ulcer. Among 223 patients with satisfactory results, one-third gained weight, one-third lost weight, and the weight of one-third remained unchanged. Among 78% with unsatisfactory results, 55% lost weight, 15% gained weight, and in 30% the weight remained the same.

The dietitian of our group (E. A. H.) studied the caloric intake of 24 persons who were markedly underweight. This study, undertaken by repeated interviews and dietary survey, while admittedly crude, indicated that the average daily caloric intake was in nearly all instances very much below the calculated requirements for maintenance of the patient's average preoperative weight.

The employment status of all patients was determined. Seventy-six per cent were working. Of those not working, one-half were over 60 years of age. Slightly over one-half of the patients were receiving retirement or disability pensions. The final clinical evaluations had no correlation with employment status or with receipt of pensions.

Comment

In comparing the present data with those in other reports, it is important to recognize differences in patient material, professional care, and criteria for postoperative evaluation. Our series is composed of an exclusively Veteran, predominantly male, group of patients who were operated upon by various members of the surgical resident staff of the hospital. The age distribution and duration of illness in our patients are similar to those reported by other authors.

All surgically treated patients concerned in this report had unusually severe peptic ulcer disease, as is exemplified by the fact that 94% of the group had at least one major life-threatening complication. Furthermore, 72% of the duodenal ulcer patients had had one or more massive hemorrhages. Almost all patients with intractable pain as an indication for surgery had had a major complication.

With the criteria that were used in assessing the clinical results, the excellent and good categories constitute satisfactory results. Thus, subtotal gastrectomy performed on patients with duodenal ulcer produced satisfactory results in 68%; when performed on patients with gastric ulcer, the results were satisfactory in 78%. This difference was largely dependent upon the high rate of recurrence among the duodenal ulcer group—9% versus 1%. The lower risk of marginal ulceration in patients with gastric ulcer has been well documented and is probably related to the difference in the gastric secretory pattern.

Malnutrition was a frequent cause of an unsatisfactory clinical result. The reasons for weight loss or inability to gain weight have not been clearly understood. Many patients, disclaiming any discomfort or unpleasant symptoms and believing that they eat as much as before operation, are unable to regain weight; their weight levels off at 20 lb. or more below their average preoperative weight. The moderately elevated fat and nitrogen loss in the feces often detected after partial gastrectomy is not usually sufficient to explain weight loss entirely on the basis of malabsorption. The most likely explanation appears to be that the patient who has lost two-thirds of his

TABLE 8.—*Results of Subtotal Gastrectomy for Duodenal Ulcer*

Author	Year	No. of Cases	Satisfactory	Recurrence
St. John et al.[20]	1939	62	73%	
Heuer et al.[21]	1944	76	82%	
Rienhoff[23]	1945	260	78%	9.0%
Allen and Welch[25]	1946	129	87%	4.6%
Gaviser[24]	1948	286	97%	1.0%
Crile et al.[31]	1948	57	77%	3.4%
St. John et al.[20]*	1948	502	82%	
Hinton[28]	1950	162	90%	1.8%
Moore et al.[27]	1950	155	76%	
Druckerman et al.[33]	1952	190	93%	4.7%
Lahey and Marshall[34]	1952	1067	96%	5.0%
Colp[35]	1952	216	94%	4.9%
Pollard et al.[36]	1952	46	87%	9.4%
Pulvertaft[37]	1952	458	82%	
Metcalf et al.[40]	1955	220	58%	
Comm., Am. Gastro-enterol Assoc. & Grimson [38, 39]*	1952	1144	75%–88%	1.8%–5.8%
Present series		253	68%	9.0%

* Series of "peptic ulcer."

stomach develops fullness and distress upon eating his usual volume of food, and then unconsciously learns to reduce his intake to accommodate the small remnant of stomach and thus to avoid unpleasant symptoms. At the same time desire for food in amounts greater than this new level of intake becomes proportionately reduced, so that satiety occurs much earlier than before.

The many reports in the literature show wide variation in the number of satisfactory results found and the rate of recurrence encountered. Some of these are presented in Tables 8 and 9 for comparison with the present report. The patients developing recurrence were not different from the remainder of the group with regard to age, duration of disease, complications, indications for surgery, and extent of stomach removed. The lone exception was the absence of recurrence in patients operated upon for cicatricial obstruction. The operation performed was a comparatively standardized procedure which has been considered adequate in most surgical clinics. The patients in this group were evaluated by personal interview rather than by questionnaire, and x-ray and laboratory tests contributed greatly to the diagnosis of recurrent ulceration. Another factor might be that patients who returned for follow-up evaluation and care were more likely to be those with gastrointestinal symptoms. However, the good response (46%) to a request to report for examination and the fact that Veterans' Administration patients are accustomed to reporting for examinations when requested make it unlikely that this was, in fact, an important factor. Actually, review of published reports (Table 8) discloses several studies showing an ulcer recurrence rate in the same range as that found in the present study. It seems distinctly possible, in fact likely, that the incidence of marginal ulcer after subtotal gastric resection for duodenal ulcer is considerably higher than is generally recognized.

TABLE 9.—*Results of Subtotal Gastrectomy for Gastric Ulcer*

Author	Year	No. of Cases	Satisfactory	Recurrence
St. John et al.[20]	1939	42	79%	
Heuer et al.[21]	1944	53	94%	
Ransom[29]	1947	138	92%	
Pulvertaft[37]	1952	94	88%	
Metcalf et al.[40]	1955	49	68%	
Present series		100	78%	1.0%

Summary

A system for follow-up study has been established at the Wadsworth General Medical and Surgical Hospital, Veterans' Administration Center, for the purpose of evaluating the long-term results of various methods of treating patients with benign peptic ulcer. The present report deals with results obtained by subtotal gastric resection in 353 cases. The duration of follow-up varied from 1 to 7 years and averaged 2.5 years. All patients were interviewed by a medical-surgical team, with liberal use of x-ray and laboratory aids. The cases were classified according to carefully delineated criteria and placed in five categories. In cases of duodenal ulcer, 68% had a satisfactory result (excellent or good), 23% had an unsatisfactory result (fair or poor), and 9% developed recurrent ulceration (failure). In cases of benign gastric ulcer, the results were satisfactory in 78% and unsatisfactory in 21%, and 1% had recurrent ulceration. The patients' opinions of

the operative result frequently failed to correlate with the physicians' evaluations.

Malnutrition was a frequent cause of an unsatisfactory clinical result, 55% of such patients demonstrating excessive weight loss. Dietetic study indicated that the weight loss was due to a markedly diminished daily caloric intake.

The difference in marginal ulcer rate accounted almost entirely for the better results obtained in gastric ulcer cases. While the recurrence rate of 9% in the duodenal ulcer group seems high, several reports of other investigators cite equivalent results. It is concluded that the marginal ulcer rate, after the usual subtotal gastrectomy for duodenal ulcer, is higher than has generally been recognized.

Department of Surgery, University of California Medical Center (24).

REFERENCES

1. Cohn, A. E., and Lingg, C., Editors: The Burden of Diseases in the United States, National Health Survey 1937, New York, Oxford University, 1950.

2. Vital Statistics of the United States, U. S. Public Health Service, Department of Health, Education, and Welfare, 1953, Vol. 2, Table 50.

3. Péan, M.: De l'ablation des tumeurs de l'estmoac par la gastrectomie, Gaz. hôp. 52:473-475, 1879.

4. Rydygier, L.: Die erste Magenresection beim Magengeschwür, Berl. klin. Wchnschr. 19:39-41, 1882.

5. Billroth, T.: Offenes Schreiben an Herrn. Dr. L. Wittelshöfer, Wien. med. Wchnschr. 6:161-165, 1881.

6. Kuh, E. J.: Eine Pylorusresection, Arch. klin. Chir. 27:789-804, 1882.

7. Narath, A.: Zur Geschichte der zweiten Billrothschen Resektionsmethode am Magen, Deutsche Ztschr. Chir. 136:62-136, 1916.

8. Finsterer, H.: Ausgedehnte Magenresektion bei Ulcus duodeni statt der einfachen Duodenalresektion bzw. Pylorusausschaltung, Zentralbl. Chir. 45:434-435, 1918.

9. Finsterer, H., and Leonardo, R. A.: Gastric Resection: Its History and Present Status, J. Internat. Coll. Surgeons 10: 639-652, 1947.

10. Marshall, S. F., and Phillips, E. S.: Gastric Surgery: A Review of the Literature, Gastroenterology 12:748-778, 1949.

11. Dragstedt, L. R., and Owens, F. M.: Supra-Diaphragmatic Section of the Vagus Nerves in the Treatment of Duodenal Ulcer, Proc. Soc. Exper. Biol. & Med. 53:152-154, 1943.

12. Harkins, H. N.; Schmitz, E. J.; Harper, H. P.; Sauvage, L. R.; Moore, H. G., Jr.; Storer, E. H., and Kanar, E. A.: A Combined Physiological Operation for Peptic Ulcer (partial Distal Gastrectomy, Vagotomy, and Gastroduodenostomy), West. J. Surg. 61:316-319, 1953.

13. Woodward, E. R.; Stevens, G. A., and Robertson, C.: Role of the Antrum in Surgery for Duodenal Ulcer, A. M. A. Arch. Surg. 72: 1003-1008, 1956.

14. Walton, J.: Progress of Gastric Surgery in the Last Half-Century, Brit. M. J. 1:206-210, 1950.

15. Moore, H. G., and Harkins, H. N.: The Billroth I Gastric Resection, with Particular Reference to the Surgery of Peptic Ulcer, Boston, Little, Brown & Company, 1954.

16. Farmer, D. A., and Smithwick, R. H.: Hemigastrectomy Combined with Resection of the Vagus Nerves, New England J. Med. 247:1017-1022, 1952.

17. Morgan, T. W.: An Experimental Evaluation of the Billroth I Operation with Vagotomy, S. Forum (1952), pp. 44-49, 1953.

18. Edwards, L. W., and Herrington, J. L., Jr.: Vagotomy and Gastro-Enterostomy-Vagotomy and Conservative Gastrectomy: A Comparative Study, Ann. Surg. 137:873-883, 1953.

19. McKittrick, L. S.; Moore, F. D., and Warren, R.: Complications and Mortality in Subtotal Gastrectomy for Duodenal Ulcer: Report on 2-Stage Procedure, Ann. Surg. 120:531-561, 1944.

20. St. John, F. B.; Harvey, H. D.; Guis, J. A., and Goodman, E. N.: A Study of the Results of Surgical Treatment of Peptic Ulcer, Ann. Surg. 109: 193-218, 1939.

21. Heuer, G. J.; Holman, C., and Cooper, W. A.: The Treatment of Peptic Ulcer Based upon 10 Years' Experience at the New York Hospital, Philadelphia, J. B. Lippincott Company, 1944.

22. Rienhoff, W. F., Jr.: An Analysis of the Results of the Surgical Treatment of 260 Consecutive Cases of Chronic Peptic Ulcer of the Duodenum, Ann. Surg. 121: 583-599, 1945.

23. Allen, A. W., and Welch, C. E.: Subtotal Gastrectomy for Duodenal Ulcer, Ann. Surg. 124: 688-707, 1946.

24. Gaviser, D.: Clinical Investigation and Evaluation of 416 Cases Consecutively Operated upon for Peptic Ulcer, Surgery 24:873-916, 1948.

25. Finsterer, H.: My Experience with Total Gastrectomy, J. Internat. Coll. Surgeons 13:675-686, 1950.

26. St. John, F. B.; Harvey, H. D.; Ferrer, J. M., Jr., and Sengstaken, R. W.: Results Following Subtotal Gastrectomy for Duodenal and Gastric Ulcer, Ann. Surg. 128:3-14, 1948.

27. Moore, F. D.; Peete, W. P. J.; Richardson, J. E.; Erskine, J. M.; Brooks, J. R., and Rogers, H.: The Effect of Definitive Surgery on Duodenal Ulcer Disease: A Comparative Study of Surgical and Non-Surgical Management in 997 Cases, Ann. Surg. 132:652-680, 1950.

28. Nicolaysen, K. and Fretheim, B.: Partial Gastrectomy for Ulcer and Postoperative Complications, Surgery 30:597-605, 1951.

29. Ransom, H. K.: Subtotal Gastrectomy for Gastric Ulcer: A Study of End Results, Ann. Surg. 126:633-654, 1947.

30. Metcalf, P. B.; Cooper, P., and Smithwick, R. H.: Subtotal Gastrectomy for Peptic Ulcer: A One to Four and One-Half Year Clinical and Laboratory Follow-Up Study, Ann. Surg. 142: 924-937, 1955.

31. Crile, G., Jr.; Jones, T. E., and Davis, J. B.: Surgical Treatment of Duodenal Ulcer: Comparison of Results With and Without Vagotomy, Ann. Surg. 130:31-37, 1949.

32. Hinton, J. W.: The Evaluation of End Results in Physiologic Versus Pathologic Operative Procedures for Chronic Duodenal Ulcer During the Past 2 Decades, Ann. Surg. 132: 641-651, 1950.

33. Druckerman, L. J.; Weinstein, V. A.; Klingenstein, P., and Colp, R.: A Comparative Study of Subtotal Gastrectomy With and Without Infradiaphragmatic Vagotomy in the Surgical Therapy of Duodenal Ulcer, Ann. Surg. 136:211-216, 1952.

34. Lahey, F. H., and Marshall, S. F.: The Surgical Treatment of Peptic Ulcer, New England J. Med. 246:115-123, 1952.

35. Colp, R.: Recent Developments in the Surgery of Peptic Ulcer, Bull. New York Acad. Med. 28:785-795, 1952.

36. Pollard, H. M.; Bolt, R. J.; Ransom, H. K., and Orebaugh, J. E.: Results of Surgical Treatment of Duodenal Ulcer: Comparison of Vagotomy and Subtotal Gastrectomy 5 years Postoperatively, J. A. M. A. 150:1476-1479, 1952.

37. Pulvertaft, C. N.: The Results of Partial Gastrectomy for Peptic Ulcer, Lancet 1:225-231, 1952.

38. Report of the Committee on Surgical Procedures, National Committee on Peptic Ulcer, American Gastroenterological Association: Pt. II: Subtotal Gastric Resection Alone and Gastroenterostomy Alone, Gastroenterology 22:405-496, 1952.

39. Grimson, K. S.: Surgical Procedures for Peptic Ulcer: A Critique of the Committee Report, Gastroenterology 24:275-280, 1953.

Pulmonary Leiomyosarcoma

Review and Report of a Case

LIEUT. COL. THOMAS H. HEWLETT (MC) and CAPT. JAMES E. McCARTY (MC), U. S. Army

Introduction

Despite the abundance of smooth muscle found within the tracheobronchial tree, primary muscle tumors within the lung are rare, as evidenced by the paucity of reports documenting such tumors.

Forkel [2] recognized a fibromyoma of the lung in a necropsy specimen and reported this finding in 1909. Neumann [7] reported instances of leiomyosarcoma in the lung in autopsy studies in 1938. The first antemortem diagnosis of pulmonary leiomyosarcoma was reported by Randall and Blades [8] in 1946. Their patient complained of hemoptysis and dyspnea. A positive biopsy specimen was obtained during bronchoscopy. Both benign and malignant muscle tumors arising in the lung have been reported sporadically during the last 10 years. Although the total number of leiomyosarcomas of the lung reported to date is small, a survey of the experience with malignancies of this type might reveal certain facts which could serve as a basis for the management of such a lesion. The 18th case is herein contributed to the total experience.

Report of a Case

A 23-year-old white man, an officer, was transferred to Brooke Army Hospital with a tentative diagnosis of "possible mesothelioma of the right lung." The patient complained of a dull pain in the right lower chest, extending into the right epigastrium. This had been present intermittently for a period of approximately three years but had never been severe enough to necessitate medical care. There were no respiratory complaints or symptoms. Routine physical examination chest films were negative in 1953 and again in 1954. No significant physical findings were noted in either examination. X-rays of the chest (Fig. 1) performed in December, 1955, revealed a homogeneous density in the right lower lung field.

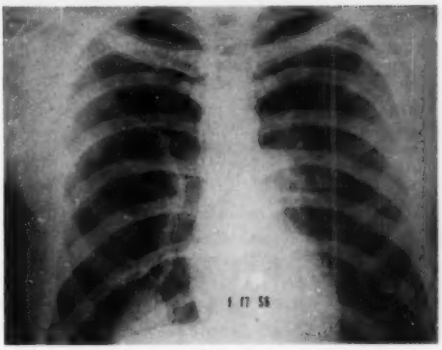


Fig. 1.—Posteroanterior film, revealing homogeneous density in the right lower lobe.

The past history was noncontributory. The only factor of interest in the family history was the father's death, at age 52, of sarcoma of the stomach, metastatic to the lungs.

Physical examination was essentially negative except for a soft, mobile mass in the right lower quadrant of the abdomen, which after careful evaluation was considered to be a mobile cecum.

X-rays of the gastrointestinal tract and the urinary tract were within normal limits. Routine hematological and urinary studies were within normal limits.

Owing to the location of the tumor mass, bronchoscopy was not performed.

On Feb. 6, 1956, a right thoracotomy was performed, with the patient under nitrous oxide, oxygen, and ether anesthesia. A firm globular mass lying centrally, within the basal segments of the lower lobe of the lung (Fig. 2), was completely removed by resection of the basal segments. The right pleural cavity and mediastinum appeared free of disease.

Cleared by the Army authorities.

Submitted for publication June 17, 1957.

Chief, Thoracic Surgery Section (Lieutenant Colonel Hewlett); Department of Pathology (Captain McCarty), Brooke Army Hospital, Texas.

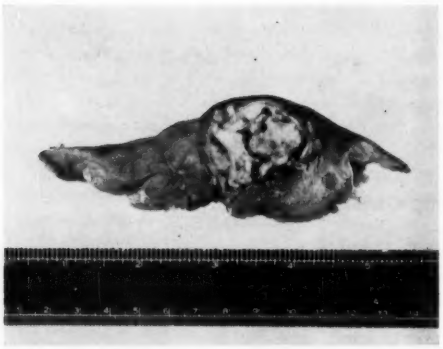


Fig. 2.—Gross specimen following fixation. Note the excellent demarcation but lack of encapsulation. Some tumor tissue has fallen from the specimen, producing the apparent cavitation.

Pathology.—The tumor measured approximately 4 cm. in diameter and, though circumscribed, was not encapsulated. The cut surface was of a pinkish-gray color, soft, friable, and slightly lobulated (Fig. 2). The lesion involved a large bronchus but did not destroy the overlying mucosa.

Microscopically, the tumor is vascular and composed of interlacing bundles of rather plump spindle-shaped cells with elongated, blunt-ended nuclei (Fig. 3). The individual cells show slight to moderate variation as to size and shape and have a considerable amount of eosinophilic, slightly granular myogenic cytoplasm, arranged in long processes. Two, and rarely three, mitotic figures are seen per high-power field (Fig. 4). The cytoplasm is red with the Masson trichrome stain. Clefts, such as appear in a mesothelioma or synovioma, are not seen, and there is very little collagen. Some necrosis is present, presumably because the tumor has outgrown its blood supply.

On the basis of the pattern, appearance, and staining qualities of the cytoplasm, the paucity of collagen, and the absence of clefts, the lesion was interpreted to be of smooth-muscle origin.

The cellularity, cellular size, and frequency of mitotic figures indicate a malignant lesion. The diagnosis of a low-grade leiomyosarcoma was concurred in by the Armed Forces Institute of Pathology.

The patient's postoperative course was uneventful, and he resumed full duty as an air-borne officer March 20, 1956.

Examination and chest roentgenograms performed in July, 1956, revealed no evidence of recurrence. The patient continued to perform full duty without complaints or symptoms. Chest films (Fig. 5) obtained during routine follow-up examination in December, 1956, revealed a peripheral area of soft infiltration in the upper right lung field.

Preoperative studies were within normal limits. Right thoracotomy was performed Dec. 24, 1956. A 1.5 cm. button-shaped tumor mass was found in the subpleural area of the anterolateral surface, anterior segment of the upper lobe. Grossly, this mass had the consistency of sponge. It was removed by wedge excision. The remaining lung, the pleura, and the mediastinum presented no gross evidence of disease. Examination of this tissue revealed it to be leiomyosarcoma.

The recurrent lesion (Fig. 6) was similar to the original in all respects. It had a subpleural location and was interpreted as representing a tumor

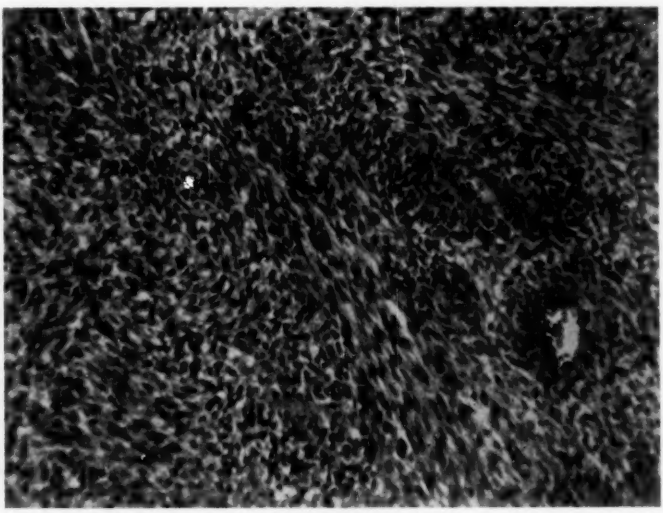


Fig. 3.—Microscopic section of primary tumor, showing vascularity and interlacing bundles of spindle cells. Hematoxylin and eosin reduced to 92% of mag. ×150. (Slides of this tumor were presented at the Annual Tumor Seminar of the San Antonio Society of Pathology in November, 1956, by Dr. Malcolm Dockerty, of the Mayo Foundation.)

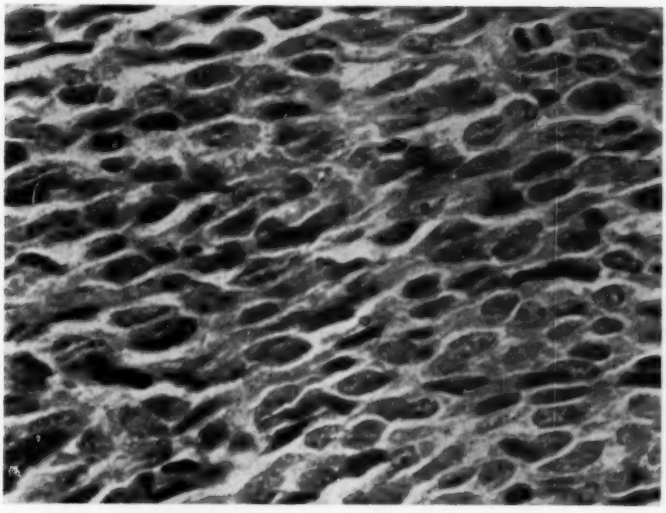


Fig. 4.—Primary tumor. The cells are relatively large, showing some variation. Mitotic figures are present. Hematoxylin and eosin; reduced to 92% of mag. × 760.

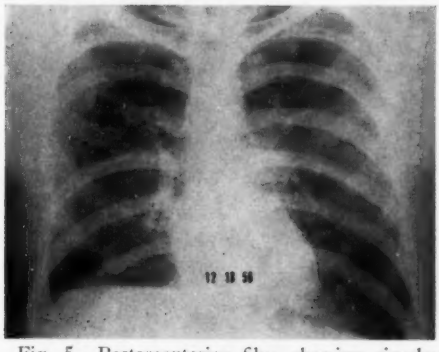


Fig. 5.—Posteroanterior film, showing circular density in right anterior second interspace.

implant from the previous operation. However, the original specimen was not sectioned in the operating room.

The postoperative course after the second operation was without incident, and the patient returned to duty. On March 24, 1957, the patient was asymptomatic; the chest films were negative, and he had resumed a strenuous military occupation.

Analysis of the Reported Experience with Pulmonary Leiomyosarcoma

These tumors have been equally distributed between the sexes and have occurred

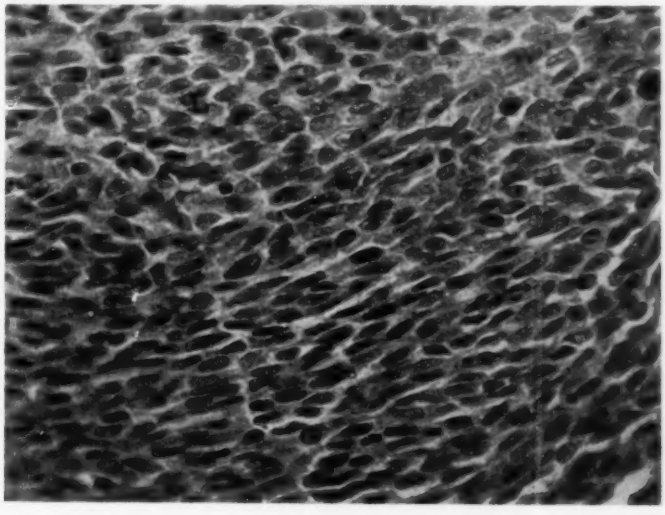


Fig. 6.—Recurrent tumor, resembling the original in all respects. Hematoxylin and eosin; reduced to 92% of mag. × 475.

Reported Cases of Pulmonary Leiomyosarcoma

Author and Date Reported	Sex	Age	Symptoms	Site	Method of Diagnosis	Treatment	Pathology	Result
Neumann[7] 1938	F	83			Autopsy			
	F	66	Dyspnea, weakness, weight loss	Left lower lobe Parenchyma	Autopsy		Metastasis to opposite lung, mediastinum, pleura, adrenal, pancreas, liver, kidney, bone	
Brunn and and Goldman[1] 1940	M	55	Dyspnea, weakness, weight loss, cough	Left lower lobe Bronchus	X-ray	Refused	Polypoid mass, left stem bronchus, infiltrating parenchyma of lower lobe; generalized metastases	
Randall and Blades[8] 1946	M	34	Hemoptysis, cough, dyspnea	Right of carina	X-ray; bronchoscopy; biopsy	Attempted pneumonectomy for bleeding	Tumor mass from carina extending into right upper lobe	Died during operation
Holinger et al.[3] 1950	F	5	Stridor and extreme obstructive symptoms	Anterior tracheal wall	Biopsy via tracheotomy	Radical excision, anterior tracheal wall	Tumor arising from extracheal rings and obstructing trachea	Alive and well at 4 yr. postop.
	F	6	Obstructive symptoms	Trachea	X-ray; bronchoscopic biopsy	X-ray	Tumor arising at carina, obstructing right main bronchus	Died of disease at 4 mo.
Mishkin[6] 1951	F	65	Cough, low-grade temperature	Left upper lobe	X-ray; autopsy	Refused	Local invasion of pleura and chest wall from LUL; parenchymal lesion	
Johnson et al.[4] 1952	M	52	Cough, chest pain, night sweats	Right upper lobe	X-ray; thoracotomy	Pneumonectomy	Tumor arising from ant. and sup. segmental bronchial orifices	Alive and well at 2 yr.
Killingsworth et al.[5] 1953	F	7	Smothering spells, motion chest diminished; breath sounds diminished	Left lower lobe	Bronchoscopy (tumor visualized; no positive biopsy); x-ray; thoracotomy	Pneumonectomy	Parenchymal origin, invading bronchus, pulmonary vein and left atrium; nodes negative	Alive and well 2 yr. postop.
Rosenberg et al.[9] 1954	M	62	Dyspnea, productive cough, acute pneumonic process	Left upper lobe	Bronchoscopy (tumor visible; biopsy neg.); thoracotomy	Pneumonectomy	Mushroom-type tumor arising from bronchus, occluding LUL; carcinoma in situ in adjacent mucosa	Alive and well at 20 mo.
Watson and Anlyan[12] 1954	M	57	Pain in chest, productive cough	Right middle lobe	Bronchoscopy (neg.); x-ray; thoracotomy	Right middle and lower lobectomy	Parenchymal tumor arising in middle lobe and directly invading lower lobe	Alive and well 9 yr. postop.
	F	63	Dyspnea and cough	Left upper lobe	Bronchoscopy (neg.); thoracotomy	Local excision	Parenchymal tumor, left upper lobe (9×7×4 cm.); pleural attachment	Patient died of heart attack in 6th postoperative year
	F	66	Cough, chest pain	Left lower lobe	Bronchoscopy (neg.); x-ray; thoracotomy (inoperable)	X-ray	Mass frozen to mediastinum with scattered pleural surface implants	Survived 11 mo.
	M	66	Weakness, no specific respiratory symptoms	Right middle lobe	Bronchoscopy (neg.); thoracotomy	Wedge excision	A subpleural parenchymal lesion, right middle lobe	Alive and well 6 yr. postop.
	M	4	Hemoptysis, cough, and dyspnea	Right middle lobe	Bronchoscopic biopsy positive; x-ray	Attempted pneumonectomy	Hilar tumor arising from lateral wall of right main bronchus; no invasion; no metastases	Died during operation
	F	67	Cough, left chest pain	Left lower lobe	Bronchoscopic biopsy positive	Refused treatment	Tumor tissue in left lower lobe bronchus	Survived 2 yr.
Tocker et al.[11] 1957	M	19	Anorexia, weakness, weight loss	Left lower lobe	Thoracotomy	Pneumonectomy	Parenchymal, primary; patient developed left pleural recurrence and generalized metastases	Survived 9 mo.
Hewlett and McCarty[7]	M	23	Right chest pain	Right lower lobe Right upper lobe	X-ray; thoracotomy	Basal segmental resection; wedge excision	Tumor arising in peribronchial tissue, basal segment, right lower lobe	Alive and well 17 mo.

predominantly in the older age group; however, such a lesion may well occur in children.

The clinical picture associated with pulmonary leiomyosarcoma is varied. As might be anticipated, chief complaints have been those associated with tracheobronchial obstruction. As a direct mechanical effect of intrabronchial lesions, such findings as cough, dyspnea, etc., were evident in 13 of the cases reported. Hemoptysis was a major symptom in only two patients. The complaint of chest pain in five patients is of interest.

Sixteen patients were studied clinically, and in all instances chest roentgenograms revealed pathology, varying from a solitary mass to a pneumonic process. Bronchoscopy yielded positive biopsy tissue in only four patients. In two patients the tumor mass could be visualized by bronchoscopy, but positive tissue was not obtained on repeated trials. Thoracotomy was necessary to obtain a diagnosis in nine cases.

Nine of the tumors reported had definite bronchial origin, a predominant site being in the vicinity of the carina. In seven instances the tumor mass was considered parenchymal in nature. Local invasion of adjacent tissue was noted in four of the parenchymal tumors. Generalized metastasis was noted in three cases. There is no report of this tumor appearing in lymph nodes.

Five patients were not treated. Of these, one is known to have survived for two years. Two patients were treated by irradiation, surviving 4 and 11 months, respectively. Eleven patients received surgical treatment. Of these, two died of technical difficulties during operation. Nine patients underwent definitive surgical therapy.

Radical excision was carried out in four patients, one of whom died of massive recurrence within nine months. Limited excision was the treatment utilized in five patients. One patient of this group has undergone a second operation for recurrence. Seven patients have survived without evident recurrence for periods ranging from two to nine years.

Comment

Leiomyosarcoma of the lung is a disease of the older age group. The clinical picture is that of an intrabronchial lesion with cough, dyspnea, and hemoptysis. Pain may be a part of the picture. Bronchoscopy and sputum studies may well be unrewarding in the diagnostic evaluation of such a case. The vascularity of the tumor is such that hemorrhage with surface sloughing may render it difficult to obtain positive tissue during bronchoscopic biopsy. A lesion of this sort does not exfoliate typical cells; therefore, sputum studies are of little value.

The possibility of muscle tumors merits some attention in the differential diagnosis of masses appearing within the lung field as noted on routine chest roentgenograms. Sherman [10] summarized the characteristic radiographic finding as a homogeneous, essentially spherical mass with clear, distinct edges. The tumor usually appears free in the lung field. However, there is no roentgenologic difference between benign and malignant tumors, and leiomyosarcoma cannot be differentiated from the commoner primary bronchogenic carcinoma, hamartomas, tuberculomas, or metastatic malignancy. An unequivocal roentgenologic diagnosis of leiomyosarcoma of the lung is impossible.

Thoracotomy is generally necessary to establish or confirm the diagnosis of leiomyosarcoma of the lung. This is true also of the leiomyoma arising within the lung.

The pathologic characteristics of leiomyosarcoma of the lung are essentially those manifested by leiomyosarcoma arising in other sites. The principal site of origin of such tumors within the lung is from the musculature of the tracheobronchial tree. The determination of parenchymal origin of a connective tissue tumor within the lung may be extremely difficult. The leiomyosarcoma may appear as an intrabronchial mass;

however, it may grow extrabronchially to invade pulmonary parenchyma.

Leiomyosarcoma of the lung grows slowly and metastasizes late. Thus, in the absence of distant metastases adequate local excision appears to be the treatment of choice. Irradiation is of no value in the management of such a tumor.

Brooke Army Hospital, Fort Sam Houston, San Antonio, Texas.

REFERENCES

1. Brunn, H., and Goldman, A.: Differentiation of Benign from Malignant Polypoid Bronchial Tumors, Surg. Gynec. & Obst. 71:703-722, 1940.

2. Forkel, W.: Ein Fall von Fibromyom der Lunge, Ztschr. Krebsforsch 8:390-393, 1909.

3. Holinger, P. H.; Slaughter, D. P., and Novak, F. J., III: Unusual Tumors Obstructing the Lower Respiratory Tract of Infants and Children, Tr. Am. Acad. Opth. 34:223-234, 1950.

4. Johnson, E. K.; Mangiardi, J. L., and Jacobs, J. B.: Primary Leiomyosarcoma of the Lung Treated by Pneumonectomy, Surgery 32:1010-1013, 1952.

5. Killingsworth, W. P.; McReynolds, G. S., and Harrison, A. W.: Pulmonary Leiomyosarcoma in a Child, J. Pediat. 42:466-470, 1953.

6. Mishkin, J. A.: Primary Myosarcoma of the Lung, New York J. Med. 51:1746-1748, 1951.

7. Neumann, R.: Leiomyosarkom der Lunge, Frankfurt. Ztschr. Path. 52:576-589, 1938.

8. Randall, W. S., and Blades, B.: Primary Bronchiogenic Leiomyosarcoma, Arch. Path. 42: 543-548, 1946.

9. Rosenberg, D.; Medlar, E., and Douglass, R.: Concurrent Primary Leiomyosarcoma and Carcinoma of the Bronchus, J. Thoracic Surg. 30: 44-48, 1955.

10. Sherman, R. S., and Malone, B. H.: A Roentgen Study of Muscle Tumors Primary in the Lung, Radiology 54:507-515, 1950.

11. Tocker, A. M.; DeHaan, C., and Stofer, B. E.: Primary Pulmonary Leiomyosarcoma, Dis. Chest 31:328-334, 1957.

12. Watson, W. L., and Anlyan, A. J.: Primary Leiomyosarcoma of the Lung, Cancer 7:250-258, 1954.

13. Watson, W. L.: Personal communication to the authors.

Carcinoma of the Parathyroid

GEORGE L. JORDAN Jr., M.D.; GEORGE W. CURD, M.D.; FERENC GYORKEY, M.D., and MICHAEL E. DeBAKEY, M.D., Houston, Texas

The frequency with which primary surgical lesions of the parathyroid gland are diagnosed clinically has steadily increased within the past 10 years. The commonest disease is hyperparathyroidism, which may be produced by primary tumors of this gland or by diffuse hyperplasia. The commonest tumor involving the parathyroid is benign adenoma; carcinoma is quite rare. In fact, Cope [5] reported that he and his associates had removed 91 benign parathyroid adenomas before they encountered their first patient with carcinoma.

The problem of the diagnosis of carcinoma of the parathyroid gland has been discussed by many authors, and opinions vary concerning the criteria necessary for this diagnosis.[1,3,5,7,9] Thus, as late as 1953 von Albertini [1] stated that the term "benign, metastasizing adenoma" was justified. This opinion is the exception, however, for other authors writing on the subject concede that those tumors which metastasize are truly carcinoma. It is also generally conceded that tumors which invade other structures locally should be classified as carcinoma. The questionable cases are those in which the diagnosis is based entirely upon the cytologic appearance of the tumor. The problem of diagnosis has made tabulation of reported cases difficult. Thus, Cope collected the cases reported up to 1953 and was able to find 35 cases in which there was general agreement that the diagnosis was correct. There were 26 additional cases which had been reported as carcinoma of the parathyroid but in which the diagnosis was questioned. The following year Black,[3] in a review of the subject, collected an additional 7 cases, and we have found 3 more, including the one reported here, making a total of 45 cases in which there was either local invasion of the tumor or the presence of distant metastases.[2,10] More than half of these tumors produced symptoms of hyperparathyroidism.

We are reporting a case of a functioning carcinoma of the parathyroid gland in which the diagnosis was suspected clinically prior to surgery because of paralysis of the left recurrent laryngeal nerve.

Report of a Case

A 42-year-old white man was admitted to the Veterans' Administration Hospital, on July 26, 1956, complaining of a sticking, constant, nonradiating pain in the right upper quadrant, of three days' duration. There had been associated nausea with vomiting of bile-stained fluid. He denied having had diarrhea, melena, or jaundice. He stated that his appetite had been poor for at least one year and there had been an associated weight loss of approximately 44 lb. (19.8 kg.) during this period. He had been examined on several occasions during the preceding 8 to 10 years because of abdominal pain, but no peptic ulcer had been demonstrated.

His past history revealed that one year prior to admission he had noted the gradual onset of hoarseness. Examination at another institution had revealed paralysis of the left vocal cord, which was attributed to exposure to paint and paint products.

Physical examination at the time of admission revealed that the temperature, pulse, and blood pressure were within normal limits, and he weighed 142 lb. (63.9 kg.). The only abnormal physical finding was tenderness in the midclavicular line just beneath the right costal margin.

The white cell count was 7200 per cubic millimeter; differential count, normal; hemoglobin,

Submitted for publication June 15, 1957.

From the Cora and Webb Mading Department of Surgery, Baylor University College of Medicine, and the Departments of Surgery, Medicine, and Pathology of the Veterans' Administration Hospital.

11.4 gm. per 100 ml.; hematocrit, 36%, and red cell count, 3,870,000 per cubic millimeter. Urinalysis was within normal limits except for a trace of albumin. Serum bilirubin, 0.2 mg. per 100 ml.; cephalin flocculation, negative; thymol turbidity, 1 unit; sulfobromophthalein U. S. P. (Bromsulphalein) retention, 5% in 30 minutes; alkaline phosphatase, 9.2 Bodansky units; serum phosphorus, 2.2 mg. per 100 ml. Stools were negative for ova, parasites, and occult blood. Urine was negative for uroporphyrin and porphobilinogen. Serum albumin, 4 gm. per 100 ml.; serum globulin, 2.7 gm. per 100 ml.; uric acid, 8 mg. per 100 ml. Gastric analysis revealed no free hydrochloric acid following histamine stimulation. Determination of the eosinophil count before and after administration of corticotropin for eight hours showed a 91% drop in circulating eosinophils. The urinary excretion of 17-hydroxycorticosteroid (corticosteroid) was 7.2 mg. for 24 hours, and that of 17-ketosteroids was 15.1 mg. for 24 hours, rising to 39.4 and 25.6 mg. per 24 hours, respectively, following the eight-hour intravenous corticotropin stimulation. Blood urea nitrogen was 35 mg. per 100 ml. The histoplasmin skin test was markedly positive.

A roentgenographic examination of the chest disclosed multiple small calcifications scattered throughout both lung fields, with slight hilar adenopathy, and a roentgenographic examination also revealed multiple small areas of calcification in the areas of both kidneys. A Graham-Cole test and an examination of the upper gastrointestinal tract following the ingestion of barium were within normal limits. Dental x-rays showed a complete absence of the lamina dura. Survey of the long bones and spine revealed no abnormality.

Initially, it was felt that the patient presented a problem in the diagnosis of gastrointestinal disease. However, the significant findings were the elevated alkaline phosphatase and blood urea nitrogen, the achlorhydria following histamine stimulation, and the renal calcinosis. Therefore, a serum calcium determination was obtained, and this was reported as being 17 mg. per 100 ml. A repeat serum phosphorus determination was 2.4 mg. per 100 ml., and a repeat alkaline phosphatase determination was 8.4 Bodansky units. Calcium excretion studies were performed on the metabolic ward following a four-day equilibration period on a 150 mg. calcium diet. The urinary calcium excretion for three consecutive days was 0.545, 0.398, and 0.512 gm., per 24 hours. Phosphorus excretion during this same period was 0.773, 0.470, and 0.710 gm., per 24 hours. The elevated uric acid was never adequately explained.

At this time reexamination of the neck disclosed a nontender mass, approximately 3 cm. in diameter, in the region of the left lower pole of the thyroid. Laryngoscopy confirmed the previous finding of paralysis of the left vocal cord. Thus, a clinical diagnosis of a functioning carcinoma of the parathyroid gland with paralysis of the left recurrent laryngeal nerve was made.

On Sept. 27, 1956, the neck was explored through a low transverse cervical incision. The mass which had been palpated was readily iden-

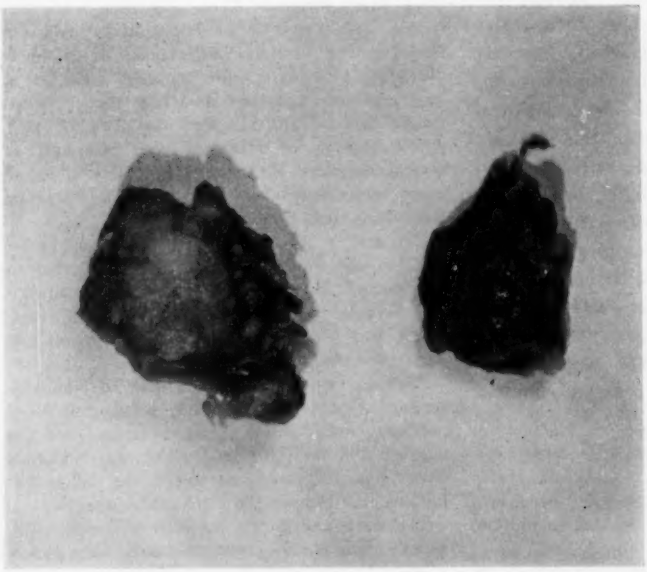


Fig. 1.—Gross appearance of the neoplastic nodule removed at operation.

tified in the region of the lower pole of the thyroid. It was hard and adherent to the lower pole of the thyroid, as well as to the cervical portion of the esophagus. The recurrent laryngeal nerve coursed through the tumor. There were no palpably enlarged nodes. A resection of the left lobe of the thyroid and the tumor, transecting the recurrent laryngeal nerve and excising a portion of the wall of the esophagus, was performed. The defect in the esophagus was closed with interrupted sutures of silk. Exploration of the right side of the neck resulted in identification of the inferior parathyroid gland. The right superior parathyroid gland was not identified, but in view of the fact that the size of the tumor was in proportion to the severity of the patient's disease, mediastinal exploration did not appear indicated.

The pathologic examination was as follows: The specimen removed consisted of a lobulated portion of gray-white tissue 2×1.5 cm. The surface was delimited by a firm capsule. Attached to it were portions of adipose tissue, connective tissue, and muscle. The cut surfaces were gray and granular. The marginal tissue was firm and up to 0.3 cm. thick (Fig. 1). In paraffin preparations, sheets and nests of neoplastic cells were interspersed by delicate connective-tissue septa, containing dilated capillaries. The cells were angular, with the cytoplasm clear pale pink and granular. The nuclei were large, oval, vesicular, or deeply stained. Many had prominent nucleoli, and some were in a state of division. Neoplastic cells close to blood vessels were palisading. The capsule was broad and hyalinized and contained small nests of neoplastic cells. Neoplastic cells extended outside the capsule into the surrounding connective tissue, adipose tissue, and striated muscle. Tumor thrombi were noted in endothelium-lined spaces. Neoplastic cells surrounded nerve sheaths. In places there were scattered areas of necrosis and recently extravasated erythrocytes (Figs. 2 and 3). A diagnosis of "malignant neoplasm of the parathyroid gland" was returned.

The left lobe of the thyroid gland, measuring 4×2.5×1 cm. and weighing 7 gm., was also removed. The surface was gray-brown, and the cut surface had a colloid sheen.

In the thyroid gland were various-sized acini, lined by cuboidal or flat cells and containing a homogeneous pink colloid. In the delicate connective-tissue septa were focal infiltrations of lymphocytes, plasma cells, and large mononuclear cells. No neoplastic cells were seen.

On the day following surgery the patient complained of acute, generalized abdominal pain and tenderness. Examination revealed slight distention and decreased bowel sounds. A serum amylase determination was reported as 86 mg. per 100 ml. (normal 40 mg. per 100 ml.). A diagnosis of acute pancreatitis was made, and therapy consisting of sedation, nasogastric suction, intravenous fluids, and antispasmodics was instituted. The pain subsided within 72 hours, and the serum amylase concentration fell to 6 mg. per 100 ml.

On Oct. 3, six days postoperatively, the patient noted tingling of the lips, toes, and hands. There was no frank tetany, and Chvostek and Trousseau signs were absent; however, the blood calcium had at this time dropped to 7.9 mg. per 100 ml. Therefore, therapy with intravenous and oral calcium was instituted; however, the urine Sulkowitch determination, positive prior to surgery, became

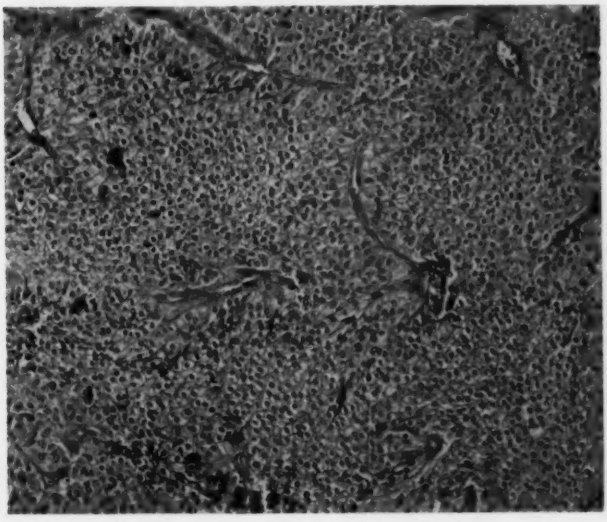


Fig. 2.—Carcinoma of parathyroid gland. Closely spaced angular neoplastic cells with small oval vesicular or deeply stained nuclei and abundant clear or faintly granular cytoplasm were palisaded around blood vessels. × 100.

Fig. 3.—Neoplastic cells outside the capsule and in adipose tissue. The lumen of an endothelium-lined space is filled with a tumor thrombus. × 100.

negative and the serum calcium concentration steadily decreased despite this therapy (Table). The patient complained of feeling weak and tired. The blood pressure gradually declined to 70 mm. Hg systolic and 40 mm. Hg diastolic. On Oct. 9, dihydrotachysterol (Hytakerol) and oral calcium gluconate were administered, with improvement of symptoms and elevation of blood pressure to previous levels. The serum calcium began to rise, and the patient improved until Oct. 14, at which time there was a sudden onset of right pleuritic pain with pleural effusion. This responded to thoracentesis and antibiotic administration, so that on Oct. 30, 1956, the patient was able to leave the hospital.

He returned on Oct. 31, 1956, with a complaint of sudden onset of marked vertigo not affected by position. The blood pressure at this time was noted to be 188 mm. Hg systolic and 120 mm. Hg diastolic. Both intramuscular and intravenous phentolamine (Regitine) tests for pheochromocytoma were within normal limits. The patient did not respond to dimenhydrinate U. S. P. (Dramamine) or reserpine (Serpasil), but within four weeks the vertigo had improved spontaneously, and his blood pressure gradually declined to 144 mm. Hg systolic and 104 mm. Hg diastolic.

By Dec. 3, 1956, the serum calcium levels had returned to normal, and dihydrotachysterol was discontinued, though calcium gluconate (1 gm. daily) was given for an additional month (Table). The patient was discharged on Jan. 23, 1957, taking no medication. At this time he was essentially asymptomatic except for slight vertigo in the morning. His weight was 149 lb. (67 kg.). During the subsequent two months he steadily improved, and his weight returned to 173 lb. (77.8 kg.). He returned to work, and at the time

Alterations in Serum Calcium, Phosphorus, Alkaline Phosphatase, Albumin, Globulin, and Urea Nitrogen Before and After Operation *

Date	Serum Calcium, Mg./100 Ml.	Serum Phosphorus, Mg./100 Ml.	Alkaline Phosphatase, Units	Serum Albumin, Gm./100 Ml.	Serum Globulin Gm./100 Ml.	Blood Urea Nitrogen, Mg./100 Ml.	Comment
8/20/56	17.0	2.4	9.2	3.6	2.9	35	
9/24/56	16.8						Parathyroidectomy 9/27/56
9/28/56	12.1	1.8				29	
10/3/56	7.9	2.0	11.6	2.7	2.8	28	Tingling of lips, fingers, toes; neg, Chvostek test, no tetany
10/9/56	6.9	3.3	12.7	2.4	2.8	14	A.T. 10, 0.625 mg. q.i.d.; Ca gluconate. 4 gm. q.i.d. started
11/5/56	8.5	2.3	6.7	3.2	3.6	29	A.T. 10, 0.625 mg. g.i.d.; Ca gluconate, 4 gm. q.i.d. with gradual reduction
12/3/56	9.0	2.2	7.2			32	No A.T. 10; Ca gluconate, 1 gm. daily
1/3/57	10.1	2.3	6.9			28	No treatment
2/5/57	9.7	2.3					No treatment
3/19/57	10.1	3.1				18	No treatment

* Onset of hypocalcemic symptoms, but without signs of tetany six days postoperatively, subsiding with replacement therapy of dihydroxy tachysterol (Hytakerol; A.T. 10) and oral calcium. These medications were administered for approximately one month, and then the dosage was gradually reduced over a three-week period, without recurrence of symptoms or signs of hypocalcemia.

of his last examination, on March 19, his serum calcium, phosphorus, and blood urea nitrogen were within normal limits. There had been no replacement of the lamina dura.

Comment

The case reported demonstrates most of the classical features of hyperparathyroidism. The history of chronic dyspepsia, weakness, muscle aches, chemical abnormalities, metastatic calcification, evidence of renal impairment, and absence of the lamina dura are characteristic. It was possible in this case to suspect the diagnosis of carcinoma, owing to the fact that the lesion was large enough to be palpable, was hard, and there was an associated paralysis of the recurrent laryngeal nerve on the same side as that on which the lesion was palpated.

An interesting feature in this case was the development of pancreatitis in the postoperative period. This disease process has been reported to occur after many surgical procedures, and it is thought to be commonest following surgical intervention for lesions of the stomach, duodenum, or gallbladder, since in operations in this region there may be direct trauma to the pancreas. Why pancreatitis should occur after surgery of the parathyroid gland is not clear, but its frequency appears to be greater than one would suspect. Thus, Bogdonoff,[4] reporting 27 cases of hyperparathyroidism encountered at Duke University Hospital, noted one case of postoperative pancreatitis. In the 4 cases of carcinoma reported by Cope[5] there was one death from postoperative pancreatitis, and Hellström,[6] reporting nonmalignant adenomas of the parathyroid, encountered only one postoperative death in 50 cases. This death was due to pancreatitis. Thus, the incidence of postoperative pancreatitis following excision of parathyroid tumors is similar to that following surgery of the stomach.[8]

This patient also presented the interesting phenomenon of elevation of blood pressure in the postoperative period. Tests for pheochromocytoma did not confirm the presence of this tumor, but the possibility that this patient might have multiple neoplasms of the endocrine glands cannot be completely excluded at this time. It may also have been related to his renal disease.

The prognosis of patients with parathyroid carcinoma is not well documented in view of the paucity of clinical experience with this disease. However, several of the cases reported indicate that the patients may live many years, even with the presence of metastatic disease. The possible beneficial effects of a radical neck dissection in the absence of palpably enlarged nodes cannot be settled on the basis of the cases which are reported. Distant metastases seem to be as common as metastases to cervical nodes outside the immediate periglandular area, and this problem must await further experience before definite conclusions can be drawn.

If the primary tumor is a functioning one, it appears likely that metastatic lesions will also show function. Consequently, careful follow-up examinations are indicated, and if hyperparathyroidism recurs, an effort should be made to localize and surgically remove areas of recurrence.

Baylor University College of Medicine, Texas Medical Center (Dr. DeBakey).

REFERENCES

1. von Albertini, A.; Koller, F., and Gaiser, H.: Functioning Parathyroid Tumors with Liver Metastasis, Acta endocrinol. 12:289, 1953.

2. Bissi, A., and Gaetani, M.: Il paratiroidoma maligno, Tumori 40:609, 1954.

3. Black, B. K.: Carcinoma of the Parathyroid, Ann. Surg. 139:355, 1954.

4. Bogdonoff, M. D.; Woods, A. H.; White, J. E., and Engel, F. L.: Hyperparathyroidism, Am. J. Med. 21:583, 1956.

5. Cope, O.; Nardi, G. L., and Castleman, B.: Carcinoma of the Parathyroid Glands: Four Cases Among 148 Patients with Hyperparathyroidism, Ann. Surg. 138:661, 1953.

6. Hellström, J.: Primary hyperparathyroidism: Observations in Series of 40 Cases, Acta endocrinol. 16:30, 1954.

7. Norris, E. H.: Carcinoma of the Parathyroid Glands, with a Preliminary Report of 3 Cases, Collective Review, Internat. Abstr. Surg. 86:1, 1948, in Surg. Gynec. & Obst., Jan., 1948.

8. Pearce, C. W.; Jordan, G. L., Jr., and De Bakey, M. E.: Intra-Abdominal Complications Following Distal Subtotal Gastrectomy for Benign Gastroduodenal Ulceration, Surgery 42:447, 1957.

9. Stephenson, H. U., Jr.: Malignant Tumors of the Parathyroid Glands, Arch. Surg. 60:247, 1950.

10. Wray, S.: Carcinoma of the Parathyroid Gland, J. Path. & Bact. 66:231, 1953.

Prescalene Lymph Node Biopsy

BURRILL N. JOSEPHS, M.D., and FRANCIS M. WOODS, M.D., Boston

In the presence of an undiagnosed intrathoracic lesion it is obvious that palpable supraclavicular lymph nodes should be submitted to biopsy. It is less clear whether prescalene node biopsy is indicated in the absence of palpable nodes. It is the purpose of this study to review a series of simple prescalene node biopsies to determine the value of this procedure as a routine, particularly with respect to carcinoma of the lung.

Daniels,[1] in 1949, and, later, Weiss et al.,[2] Johnson and MacCurdy,[3] and Storey and Reynolds[4] first described prescalene node biopsy as a means of diagnosing intrathoracic disease. Several subsequent series have been reported that have not distinguished between patients with palpable and those with nonpalpable supraclavicular nodes. Among these,[5-9] positive diagnoses were obtained in 25% to 40%. Sarcoidosis (Boeck's Sarcoid) was the most frequent diagnosis in the three series of over 100 cases.[5,6,9] Other diagnoses included histoplasmosis, Hodgkin's disease, tuberculosis, lymphoblastoma, plasmocytoma, sarcoma, and metastatic carcinoma from the lung, esophagus, prostate, pancreas, and cervix.

In contrast, several other reports have been confined to prescalene node biopsy in the absence of palpable supraclavicular lymph nodes. Harken et al.[10] supplemented simple prescalene node biopsy with an extension into the superior mediastinum and reported 45 (32%) positive biopsies in 142 cases. A majority (31 of 45) of these positive biopsies revealed carcinoma of the lung. These authors emphasize that "half the positive results came from tissue removed from the mediastinum and not the scalene fat pad." In Connar's[14] series, 9 of 42 patients with nonpalpable nodes had diagnostic biopsies, and, again, the majority had carcinoma of the lung. Seghers and associates,[9] using a simple prescalene node biopsy, found involved nodes in only 14 of 132 "proved or suspected" cases of bronchogenic carcinoma. In other reports[11-13] positive diagnoses were obtained in 19% to 55% of cases; but sarcoid predominated.

Present Study

Material.—A review was made of the records of all patients at the Veterans' Administration Hospital who underwent simple prescalene node excision between July, 1952, and July, 1956, for the diagnosis of an intrathoracic lesion of unproved etiology.

Technique (Figure).—With local anesthesia, an incision is made above the clavicle, centered over the lateral border of the sternocleidomastoid muscle. The skin and platysma muscle are mobil-

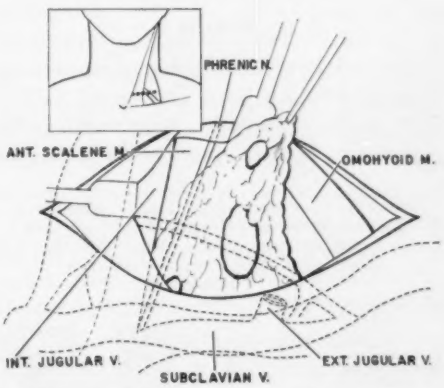


Diagram showing technique of operation.

Submitted for publication May 27, 1957.

From the Surgical Service, Veterans' Administration Hospital.

Resident in Surgery, Veterans' Administration Hospital (Dr. Josephs). Associate, Overholt Thoracic Clinic; Attending Thoracic Surgeon, Veterans' Administration Hospital; Clinical Assistant Professor of Surgery, Tufts University Medical School (Dr. Woods).

ized, and the deep cervical fascia is incised along the edge of the muscle. The underlying prescalene fat pad is excised superiorly under the omohyoid muscle, medial to the internal jugular vein and inferior to the subclavian vein, thus exposing the anterior scalene muscle and the phrenic nerve. The wound is closed in layers. This dissection is, in part, retroclavicular,[7] but is not carried down to the confluence of the internal jugular and subclavian veins, which marks the entrance into the mediastinum. The paratracheal region is not explored or palpated.

All operations were performed by the resident staff. In 5 of the 125 cases no lymph nodes were found in the specimen by the pathologist. These biopsies were accepted as negative. Connar[14] considers prescalene node biopsies inadequate if there are less than four lymph nodes found in the specimen, and in such cases he recommends a second biopsy.

Selection of Side.—In accordance with Rouvière's[15] description of the lymphatic drainage of the lung, a right-sided prescalene node biopsy was selected for right lung lesions. With one exception, either a right-sided or a bilateral biopsy was done for left lower lung field lesions. A left prescalene node biopsy was reserved for left upper lung field lesions except in one case, where there were bilateral palpable supraclavicular nodes. Bilateral biopsies were performed for three left lower lobe lesions, for one in the left midlung field and for one in the right upper lobe.

Complications.—Reported complications resulting from prescalene node biopsy are uncommon but include hemorrhage,[10] pneumothorax,[10] a transient Horner syndrome,[5,6] and lymph drainage.[5,14] None of the first three was encountered in this series of simple prescalene node biopsies; an occasional lymphocele has been treated by aspiration and pressure dressing, and, in some recent cases, prevented by drainage of the wound for 24 hours.

Results

The results of 125 simple prescalene node biopsies were analyzed. Forty-six (37%) were positive (Table 1). Also shown is the correlation between positive biopsies and the presence of palpable supraclavicular nodes. The list of diagnoses obtained is presented in Table 2.

Table 3 presents the results of simple prescalene node biopsy in the 78 cases of proved carcinoma of the lung. In Table 4 the site of the lesion in these cases is correlated with the side and the results of the biopsy. Because the pattern of lymph drainage from the lungs is not dependent upon the lobe involved, the location was simply designated as mediastinal or in the upper, middle, or lower lung field, as judged by the chest x-ray. In lesions overlapping

TABLE 1.—*Correlations of Simple Prescalene Lymph Node Biopsy with Palpability of Supraclavicular Lymph Nodes in 125 Cases of Undiagnosed Intrathoracic Disease*

	No.	Positive	Negative
Palpable	34	28 (82%)	6 (18%)
Nonpalpable	91	18 (20%)	73 (80%)
Total	125	46 (37%)	79 (63%)

TABLE 2.—*Diagnoses Obtained by Simple Prescalene Lymph Node Biopsy in 125 Cases of Intrathoracic Disease*

Final Diagnosis	Total Cases	Positive Biopsy
Carcinoma of the lung	78	32
Inflammatory disease	13	0
Hodgkin's disease	7	7
Granuloma	6	1
Sarcoid	3	3
Metastatic carcinoma of esophagus	2	2
Sarcoma of the lung	2	0
Metastatic carcinoma of unknown origin	1	0
Metastatic carcinoma of prostate	1	1
Substernal thyroid	1	0
Total	114 *	46

* Eleven additional cases remained undiagnosed.

TABLE 3.—*Results of Simple Prescalene Node Biopsy in Seventy-Eight Proved Cases of Carcinoma of the Lung*

	Palpable	Nonpalpable	Total
Supraclavicular nodes	19	59	78
Biopsy			
Positive	16 (84%)	16 (27%)	32 (41%)
Negative	3 (16%)	43 (73%)	46 (59%)

TABLE 4.—*Results of Eighty-Three Simple Prescalene Node Biopsies in Seventy-Eight Cases of Carcinoma of the Lung Arranged According to Side of Biopsy and Site of Lesion by X-Ray*

Site of Lesion by X-Ray	Side of Biopsy			
	Right (54)		Left (29)	
	Positive	Negative	Positive	Negative
Right upper lung field	6	16	0	1
Right middle lung field	1	2	0	0
Right lower lung field	5	4	0	0
Hilar and mediastinal	8	0	5	1
Massive effusion	1	2	0	1
Left upper lung field	1	0	4	11
Left middle lung field	0	2	0	2
Left lower lung field	1	5	0	4
Total	23	31	9	20

more than one area the lung field predominantly involved was selected. Forty-three per cent of the right-sided and 31% of the left-sided biopsies were positive. Ten prescalene node dissections were done for seven left lower lung field lesions (three being bilateral); the only positive result obtained was from the right side, thus supporting Rouvière's study. There were 14 cases of carcinoma of the lung presenting primarily as hilar and mediastinal shadows on x-ray. The biopsy was performed on the side on which the lesion was most prominent. Of the 14, 13 (93%) yielded positive results.

Comment

Recent anatomic studies[7] have reemphasized the intimate association of the lymph nodes in the scalene fat pad and the superior mediastinum. As a result, involvement of the mediastinal nodes by pulmonary lesions or by systemic diseases often is reflected in the scalene nodes. "In a very real sense, simple scalene node biopsy is a biopsy of the mediastinal nodes without the necessity of entering the thorax" (Shefts et al.[5]).

In this series prescalene node biopsy without mediastinal dissection was performed, as advocated by Shefts[5] and Connar,[14] for maximum safety and simplicity. Neither the paratracheal region nor the mediastinum below this was palpated or explored.

The proportion (37%) of positive prescalene node biopsies is comparable to that reported by others. Hodgkin's disease and sarcoidosis involve the lymphatic system; it is not surprising, therefore, that in our series every such case presenting as undiagnosed intrathoracic disease was identified from the prescalene nodes. Although other diseases were diagnosed by this method, its value was particularly illustrated on one occasion by the unexpected finding of metastatic carcinoma of the prostate. The chief complaint in this patient was dyspnea, and chest x-ray revealed diffuse pulmonary infiltration; but it was the biopsy that directed attention to the prostate.

There were 28 (82%) positive diagnoses among 34 cases with palpable supraclavicular nodes. The pathologist reported only reactive hyperplasia in the other six cases, in five of which the diagnosis ultimately proved to be carcinoma of the lung, whereas one remained undiagnosed.

Of the 91 cases with nonpalpable supraclavicular nodes, the diagnosis was made by prescalene node biopsy in 18 (20%). A higher yield (32% in Harken's series) of positive results has been reported by extension of the exploration into the mediastinum; however, this has not seemed warranted because of the prolongation of the operative time, discomfort to the patient, and hazard of hemorrhage and pneumothorax.

The major attention of this study was focused on the group of 78 patients with carcinoma of the lung. With the exception of the series of Harken and Seghers, our series is the only sizable one composed predominantly of such cases. If supraclavicular nodes are palpable, it is axiomatic that they should be studied microscopically. This is emphasized by the fact that in our series 16 of 19 such nodes (84%) were diagnostic. Even among 66 cases in which no nodes were palpable, simple prescalene node biopsy showed metastatic bronchogenic carcinoma in 16 (27%). This approximates the diagnostic accuracy of bronchoscopy, which is 30% in the recent experience of the Overholt Thoracic Clinic.

In view of the worth-while percentage of positive results obtained by simple prescalene node biopsy, we feel that routine use of this procedure is indicated in all cases of suspected carcinoma of the lung except for small peripheral lesions. Our series does not contain enough of these cases for evaluation. Our data do point out the value of such a biopsy regardless of the lung field in which the lesion is located. In our experience carcinoma involving pri-

marily the hilus and mediastinum almost always involved the prescalene nodes, too.

Since metastasis to prescalene nodes precludes curative lung resection, 32 (41%) of the 78 patients with bronchogenic carcinoma were spared unnecessary thoracotomy. Thus, simple prescalene node biopsy is indicated even in carcinoma of the lung already proved by bronchoscopic biopsy.

Summary

The value of routine simple prescalene node biopsy was assessed in a series of undiagnosed intrathoracic lesions. The final diagnosis was predominantly bronchogenic carcinoma. The operation is simple and free of the complications encountered with added mediastinal extensions. It provides diagnostic results in a significant proportion of cases, even in the absence of palpable supraclavicular nodes. Therefore it is indicated routinely in all patients with undiagnosed intrathoracic lesions, except perhaps for lesions that are small and peripheral. An additional value in suspected bronchogenic carcinoma is the determination of incurability.

Overholt Thoracic Clinic, 135 Francis St. (15) (Dr. Woods).

REFERENCES

1. Daniels, A. C.: A Method of Biopsy Useful in Diagnosing Certain Intrathoracic Diseases, Dis. Chest 16:360-366 (Sept.) 1949.

2. Weiss, H. A.; Campbell, R. M.; Budenz, G. C., and McCandless, C. M., Jr.: Sarcoidosis Diagnosed by Means of Subclavian Lymph Node Biopsy, J. A. M. A. 146:1221-1222 (July 28) 1951.

3. Johnson, J. E., Jr., and MacCurdy, J. M.: Pulmonary Histoplasmosis Diagnosed by Scalene Node Biopsy, Am. Rev. Tuberc. 66:497-500 (Oct.) 1952.

4. Storey, C. F., and Reynolds, B. M.: Biopsy Techniques in the Diagnosis of Intrathoracic Lesions, Dis. Chest 23:357-382 (April) 1953.

5. Shefts, L. M.; Terrill, A. A., and Swindell, H.: Scalene Node Biopsy, Am. Rev. Tuberc. 68: 505-522 (Oct.) 1953.

6. Piper, C. A.: Scalene Node Biopsy in Diagnosis of Diseases of the Chest, Am. Pract. & Digest Treat. 5:182-183 (March) 1954.

7. Foley, F. E.; Philbin, P. H.; Kilpatrick, J. T., and Mansfield, M. O. P.: Scalene Node Excision, Surgery 40:546-553 (Sept.) 1956.

8. Correll, N., and Langston, H. T.: The Diagnosis of Pulmonary Lesions, Illinois M. J. 109: 117-119 (March) 1956.

9. Seghers, K. K. M. F.; Orie, N. G. M.; Hadders, H. N., and Minderhout, J. M.: Daniels's Biopsy in the Diagnosis and Treatment of Pathological Processes in the Lungs and Mediastinum, Arch. chir. neerl. 6:57-64, 1954.

10. Harken, D. E.; Black, H.; Clauss, R., and Farrand, R. E.: A Simple Cervicomediastinal Exploration for Tissue Diagnosis of Intrathoracic Disease, New England J. Med. 251:1041-1044 (Dec. 23) 1954.

11. Cuykendall, J. H.: Use of Prescalene Lymph Node Biopsy in Absence of Palpable Supraclavicular Nodes: Report of 41 Cases, J. A. M. A. 155:741-742 (June 19) 1954.

12. Carstensen, B.; Norviit, L., and Odelberg, A.: Experiences with Retroclavian Lymph Node Biopsy in the Diagnosis of Certain Intrathoracic Diseases, Dis. Chest 25:443-447 (April) 1954.

13. Kenney, L. J., and Mota, C.: Scalene Lymph Node Biopsy, Henry Ford Hosp. M. Bull. 4:36-41 (March) 1956.

14. Connar, R. G.: Prescalene and Deep Cervical Lymph Node Biopsy, Surg. Gynec. & Obst. 101:733-743 (Dec.) 1955.

15. Rouvière, H.: Anatomy of the Human Lymphatic System: A Compendium Translated from the Original "Anatomie des lymphatique de l'homme" and Rearranged for the Use of Students and Practitioners, by M. J. Tobias, Ann Arbor, Mich., Edwards Brothers, Inc., 1938.

Traumatic Pseudocyst Formation of the Parotid Duct

A Safer Method of Obliteration

RUDOLPH M. LANDRY, M.D., Chattanooga, Tenn.

Injuries of the parotid duct usually result from lacerating wounds, and occasionally from surgical trauma. Clean lacerations can be repaired successfully in the great majority of cases by primary suture over a temporary dowel.[2,3,5,11-13] This has the advantage of avoiding the complications of pseudocyst formation and external salivary fistula and of preserving function of the gland. Unrecognized injuries of the parotid duct or injuries resulting in fraying, or loss of a part of the duct, usually result in subcutaneous collection of saliva and subsequent fistula formation. This may be difficult to correct. For fistulae originating in the anterior portion of the duct, the operation of Deguise has been recommended.[1,4,6,8,10] This consists simply of passing both ends of a suture through the fistula into the buccal cavity and tying the ends tightly within the mouth. The suture cuts through the tissues and converts an external fistula into an internal one. For fistulae originating in the more posterior portion of the duct, the method, variously credited to Braun,[8] Crouse,[6] and Nicoladani,[1] of constructing a duct from a flap of buccal mucosa and anastomosing it to the proximal end of the parotid duct has been advised. However, many believe that the success of these methods is the result of actual obliteration of the duct, with subsequent atrophy of the gland. Ligation of the duct has been thought contraindicated because of the possibility of swelling and cyst formation within the parotid gland, but more recent accumulation of experience indicates that ligation is safe, and leads only to physiological atrophy of the gland.[7,9,12] X-ray treatment to the parotid gland to suppress secretion has also been advocated.[12] Usually this produces only a temporary secretory failure, but cicatricial stenosis of the duct may prevent further leakage.

Parotid-duct injuries frequently are associated with injuries to branches of the facial nerve because of their anatomic proximity. The fine caliber of these twigs makes identification and repair impossible in most cases,[12] and, though facial weakness frequently improves spontaneously, this is unpredictable.

The following case is presented to illustrate a safer method for ligating the parotid duct and avoiding injury to branches of the facial nerve.

Report of a Case

A 37-year-old white man was admitted to Newell Hospital Dec. 19, 1953, after having been in a fight. He had been rendered unconscious for an indeterminate time and had suffered an oblique knife wound across the left cheek. Blood loss was severe and required subsequent transfusion. Inspection of the wound revealed the parotid gland to be lacerated, but no injury to the duct or facial nerve was detected. The wound was cleansed and repaired, suturing the capsule of the gland. Postoperatively, the patient developed a transient dilatation of the left pupil but otherwise made an uneventful recovery. He was dismissed from the hospital Dec. 26, and the wound was healed. Subsequent examinations revealed steady improvement, and no complications were noted. However, on Jan. 7, 1954, the patient returned because of

Submitted for publication May 10, 1957.

From the Surgical Service of the Newell Hospital.

development of a cystic swelling under the masseteric portion of the scar. Aspiration was carried out, 8 cc. of watery fluid removed, and a collodion dressing applied. The free flow of saliva from the orifice of the duct proved its patency. On the next visit, the patient stated that the fluid reaccumulated almost immediately, and aspiration again yielded 15 cc. of watery fluid. The space promptly refilled, and subsequent aspirations, attempting to secure spontaneous closure of the duct, resulted in no improvement, the cyst refilling almost immediately, even though the duct remained patent. It was felt that the duct had suffered a small laceration and subsequently developed a pseudocyst. Because of the impending danger of external salivary fistula, repair was advised. Reoperation was performed on Feb. 9. Originally it was planned to reconstruct the duct by plication; however, excision of the paper-thin scar over this dilated portion of the duct revealed a large, glistening sac, surrounded by dense scar tissue. It was felt that dissection of this was likely to result in further injury to the duct, or to branches of the facial nerve, or to both. Therefore, ligation of the duct seemed to offer the best chance for recovery. The cyst closely resembled an aneurysm, and it was obvious that ligation from within the cyst offered the safest means of obliterating the duct and avoiding injury to adjacent branches of the facial nerve. The proximal opening of the duct was identified easily with a probe and the ostium closed with two interrupted silk sutures. The procedure was repeated at the distal opening and the walls obliterated by suture. The skin was closed superficial to this. The patient made an uneventful recovery and was dismissed from the hospital on Feb. 11. The wound healed primarily, and there was no evidence of facial weakness. Slight, painless swelling of the parotid gland was noted on Feb. 13. 1954. The patient has not returned for reexamination, but recent telephone conversation reveals that he has made a complete recovery.

Comment

Injury to the parotid duct leading to pseudocyst formation, contained externally only by a paper-thin scar, seemed an almost certain prelude to fistula formation, even though the duct was patent. The original plan for repair was to attempt reconstruction of the duct by plication of the walls of the cyst. However, the dense scar tissue present invited further injury to the duct itself, or the facial nerve, or both. Since this pseudocyst resembles an aneurysm, obliteration by intracystic ligation was felt to offer the safest solution to the problem. It effectively occluded the ends of the duct with minimal disturbance of the surrounding tissue, exactly as an endoaneurysomorrhaphy effectively preserves maximal collateral circulation for a lesion in the arterial tree. This method produced an excellent result in this particular case. Although it is unlikely that one surgeon would encounter many identical situations, intracystic ligation of the parotid duct is offered as a simple solution to a difficult problem.

Summary

The majority of clean lacerations of the parotid duct can be repaired successfully, preserving the function of the gland.

Unrecognized injuries or ragged injuries to the parotid duct frequently result in an external salivary fistula, which may be difficult to cure.

Cystic dilatation or pseudocyst formation of the parotid duct may result from injury, and may be a prelude to fistula formation.

Ligation or cicatricial stenosis of the duct results in physiological atrophy of the parotid gland.

Concomitant injury to facial nerve branches is a common finding with parotid-duct injuries.

A means of intracystic suture ligation of the parotid duct is presented. This procedure has the advantages of simplicity and safety, avoiding danger of further nerve injury and producing physiological atrophy of the gland.

707 Walnut St.

REFERENCES

1. Andrews, E. W., in Surgery: Its Principles and Practice, edited by W. W. Keen, Philadelphia, W. B. Saunders Company, 1912, Vol. III, Chap. 37, p. 322.

2. Brohm, C. G., and Bird, C. E.: Primary Repair of Severed Parotid Duct, J. A. M. A. 104:733-734 (March 2) 1935.

3. Christofferson, E. A.; Ajalat, M. P., and Gradman, R.: Successful Primary Repair of

Lacerated Parotid Duct, Am. J. Surg. 59:592-593 (March) 1943.

4. Da Costa, J. C.: Modern Surgery, Ed. 7, Philadelphia, W. B. Saunders Company, 1914, p. 914.

5. Goodall, R. E., and Flanders, S. E.: Successful Primary Repair of Lacerated Stensen's Duct, Surgery 21:865-869 (June) 1947.

6. Horsley, J. S.: Operative Surgery, Ed. 2, St. Louis, C. V. Mosby Company, 1924, Chap. XV, pp. 270-271.

7. Ivy, R. A., cited by Sparkman.[12]

8. McGrath, J. J.: Operative Surgery, Ed. 6, revised, Philadelphia, F. A. Davis Company, 1921, Pt. II, pp. 152-155.

9. Morestin, H., cited by Sparkman.[12]

10. Rives, J. D., in discussion on Sparkman,[12] p. 167.

11. Sparkman, R. S.: Primary Repair of Severed Parotid Duct: Review of Literature and Report of 3 Cases, Tr. South. Surg. A. 60:108-117, 1948; Ann. Surg. 129:652-661 (May) 1949.

12. Sparkman, R. S.: Laceration of Parotid Duct: Further Experiences, Tr. South. Surg. A. 61:156-167, 1949.

13. Wallace, F. T.: Primary Repair of the Parotid Duct, Am. J. Surg. 70:412-413 (Dec.) 1945.

Carcinoma of the Breast Associated with Discharge from the Nipple but No Palpable Mass

HERBERT E. MADALIN, M.D.; F. HENRY ELLIS Jr., M.D., and JOHN R. McDONALD, M.D., Rochester, Minn.

Many investigators have expressed various opinions concerning the significance of a discharge from the nipple, but few have specifically considered the problem of carcinoma of the breast associated with discharge from the nipple in the absence of a palpable mass. Some earlier investigators reported that more than 50% of such breasts were malignant, but the weakness of their studies was the misinterpretation of the so-called papillary lesions. In the past many lesions which are now recognized to be papillomas were called "carcinomas."

Geschickter [1] found cancer of the breast eventually developing in 9% of patients presenting themselves with discharge from the nipple. On the other hand, Bell [2] had never seen a carcinoma of the breast associated with a discharge from the nipple in the absence of a palpable mass. The present study was undertaken to determine the incidence of cancer of the breast in patients whose only symptom and physical finding was discharge from the nipple.

In a previous study [3] we reported our findings in 100 breasts treated for discharge from the nipple by simple amputation. One of the conclusions of that study was that, although discharge from the nipple may be the initial symptom of carcinoma of the breast, it is not so serious a symptom as has been implied in the past.

Submitted for publication July 8, 1957.

Fellow in Surgery, Mayo Foundation (Dr. Madalin). Section of Surgery (Dr. Ellis) and Section of Surgical Pathology (Dr. McDonald), Mayo Clinic and Mayo Foundation. The Mayo Foundation, Rochester, Minn., is a part of the Graduate School of the University of Minnesota.

Methods

In our present study we investigated the pathologic reports on all carcinomatous breasts removed during the 10 years from Jan. 1, 1945, through Dec. 31, 1954. During this time the diagnosis of carcinoma of the breast was made by the pathologist in 3193 instances. After reviewing our material, we were able to find a total of only seven cases of carcinoma of the breast in which discharge from the nipple without an associated palpable mass occurred. One of the lesions was discovered in the course of our previous study. These seven cases constitute the basis of the present report. Any patient having a discrete mass on physical examination or clinical Paget's disease (carcinoma simplex of the nipple) was excluded from consideration in this study.

Results

Age.—The age of the seven patients ranged from 41 to 79 years, the average being 58 years (Table 1).

Nature of Discharge.—In five of the breasts the discharge was said to be bloody. In one it was brownish, whereas in the other it was said to be "cloudy, serous." Since in our earlier study we found that a brownish discharge almost always indicated blood, we will consider it as a bloody discharge.

Duration of Discharge.—The shortest duration of discharge in this group was in a patient who was first noted to have a bloody discharge from her right nipple on physical examination (Table 1). This patient first sought attention for a mass in her other breast, which proved to be scirrhous carcinoma. The longest duration of discharge was 22 months.

Mass.—One of the patients gave a history of having an inflammatory mass one year prior to admission, but at the time of

TABLE 1.—*Age of Patient, Findings at Examination, and Nature of the Operation*

Case No.	Age, Yr.	Nature of Discharge	Duration of Discharge	Mass	Nature of Operation; Side of Simple Mastectomy
1	61	Bloody	8 mo.	Shotty nodules, both breasts	Right
2	61	Cloudy, serous	1 yr.	None *	Left, followed by radical mastectomy
3	53	Bloody	22 mo.	None	Right
4	47	Brownish	1 yr.	None	Left, followed by radical mastectomy
5	41	Bloody	Detected at examination	None	Right †
6	79	Bloody	2 mo.	None	Right, plus node dissection
7	62	Bloody	2 wk.	Finely nodular	Left, followed by radical mastectomy

* The patient had a history of having an inflammatory mass in her breast one year prior to examination. There was a small area of fat necrosis in her breast in addition to the carcinoma.

† This patient had left radical mastectomy for adenocarcinoma, Grade 3, one week earlier, having presented clinically a mass without discharge in that breast. Carcinoma was detected in her right breast after cutting the breast on a slicing machine. This case has been reported previously.

examination at the Clinic no mass was felt. At pathologic examination this patient's breast had, in addition to a multicentric comedocarcinoma, a small area of fat necrosis, probably a residual of previous inflammation.

Diffuse nodularity was noted in the breasts of two patients on clinical examination, but the examining physician did not consider this finding significant. In one of these patients one breast was said to be "finely nodular," and in the other patient "shotty nodules" were found in both breasts.

Operation.—Simple mastectomy was the primary operation on all these patients (Table 1). The 79-year-old patient also had dissection of the axillary nodes, while three others had immediate radical mastectomy on report of the frozen sections.

Pathologic Findings.—The lesion in all the breasts was comedocarcinoma (Figs. 1 to 4; Table 2). Two of these lesions showed evidence of infiltration, and the other five were carcinoma in situ. The lesions were graded according to the method of Broders as follows: one, grade 1; four, Grade 2, and two, Grade 4. Of the infiltrative lesions, one was Grade 2, while the other was Grade 4.

Nature of the Lesion.—Four of the lesions were multicentric, and three seemed to be localized on pathologic examination. Of the latter three, one was 9 mm. in diameter, one was 2 cm., and the other was only 3 to 4 mm. The last was detected only after slicing the entire breast on a meat-slicing machine. This case has been reported previously.[3]

One may well wonder why these lesions were not detected clinically. On reviewing the specimens, we found that only two lesions had infiltrated, as has been mentioned, whereas the others were in situ, with little or no scirrhous reaction. The consistency of these noninvasive forms should be much the same as that of the normal breast. When invasion was found, one lesion showed almost no fibrous reaction (Case 2), while the other (Case 6) had only small localized areas of fibrosis.

Thus, the reason for lack of a clinically palpable mass seems related to these lesions being early and having been brought to the attention of the clinician because of the discharge from the nipple. A further reflection of the earliness of these lesions is that of the four patients who had node dissections; none showed evidence of metastasis to the nodes.

TABLE 2.—*Pathologic Findings*

Case	Grade of Lesion	Type of Lesion	Discrete Lesion	Multicentric Lesion	Infiltration	Nodes
1	1	Comedocarcinoma	9 mm.		None	
2	4	Comedocarcinoma		+	Yes	Negative
3	4	Comedocarcinoma		+	None	
4	2	Papillary and solid comedocarcinoma		+	None	Negative
5	2	Comedocarcinoma	3 mm.		None	
6	2	Papillary and comedocarcinoma	2 cm.		Yes	Negative
7	2	Comedocarcinoma		+	None	Negative

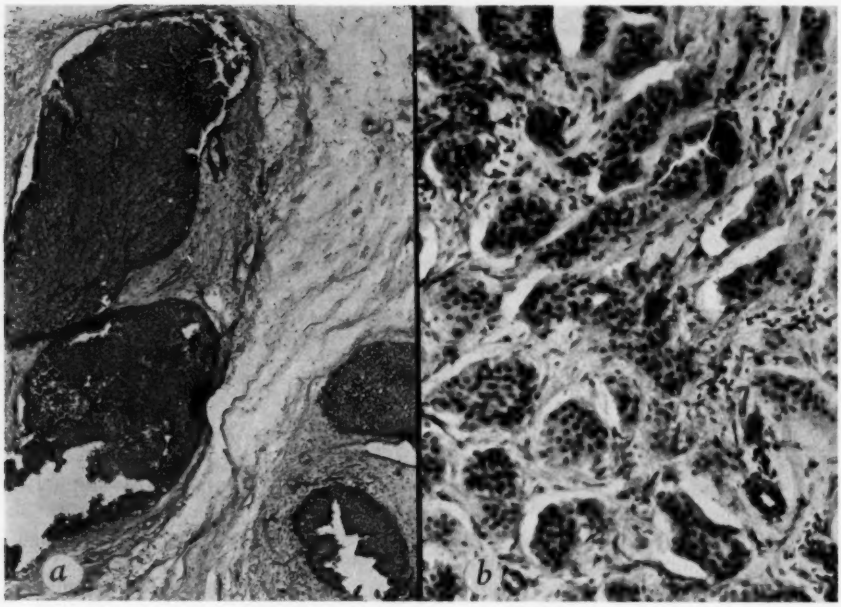


Fig. 1.—(*a*) (Case 1), comedoadenocarcinoma without infiltration, in a 61-year-old woman. Hematoxylin and eosin; × 40. (*b*) (Case 2), comedocarcinoma and infiltrating adenocarcinoma in a 61-year-old woman. Hematoxylin and eosin; × 30.

Follow-Up.—It was possible to obtain follow-up data on all of these patients within the past year: three by examination at the clinic, three by personal letter, and one by a letter from her physician (Table 3). Six of the patients were free of recurrence or metastasis. One patient died three and one-half years after operation, at the age of 82 years. She had mental aberration at the time of operation. Her physician in her home locality mentioned that she had visual hallucinations and depression the last one and one-half years of her life. Terminally, she had Jacksonian

Fig. 2 (Case 3).—Comedoadenocarcinoma in situ in a 53-year-old woman. Hematoxylin and eosin; × 200.

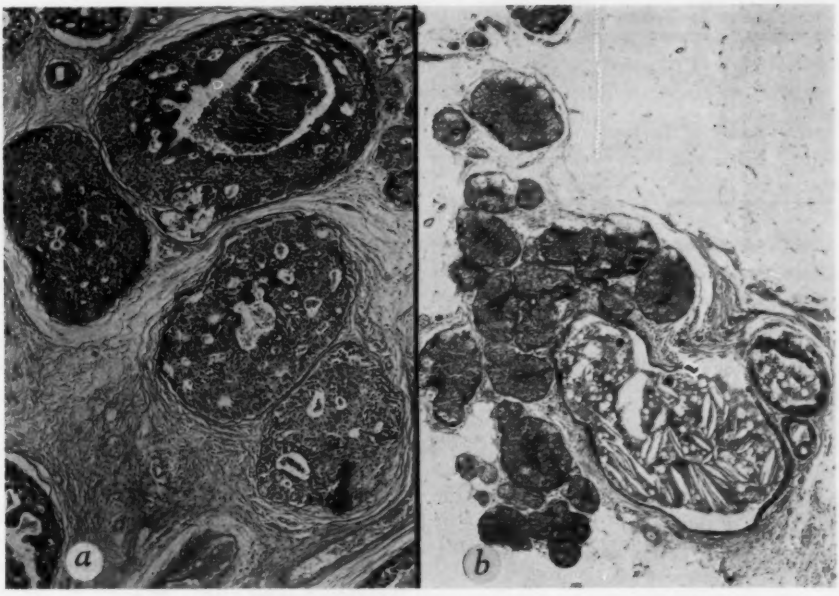


Fig. 3.—(*a*) (Case 4), papillary and solid comedoadenocarcinoma without infiltration in a 47-year-old woman. Hematoxylin and eosin; × 60. (*b*) (Case 5), comedoadenocarcinoma in situ in a 41-year-old woman. Hematoxylin and eosin; × 30.

Fig. 4.—(*a*) (Case 6), papillary and comedoadenocarcinoma with infiltration in a 79-year-old woman. Hematoxylin and eosin; × 60. (*b*) (Case 7), comedoadenocarcinoma in situ in a 62-year-old woman. Hematoxylin and eosin; × 30.

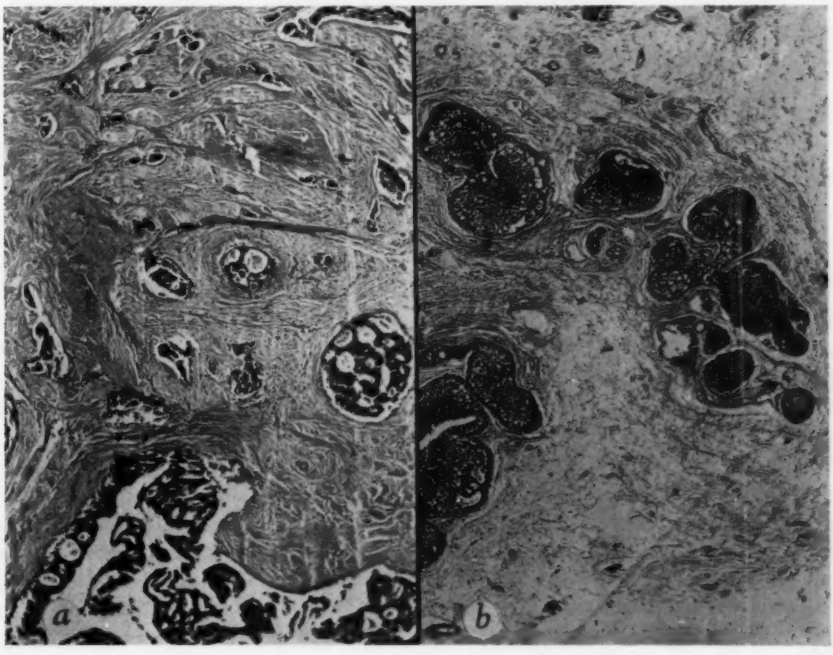


TABLE 3.—*Follow-Up Data*

Case	Follow-Up Interval, Yr.	Means of Follow-Up	Follow-Up Data
1	11	Letter	Good general health; cyst noted near scar
2	11	Examination	No recurrence or metastasis; pancreatic calcification for more than 10 yr.
3	10	Examination	No recurrence or metastasis; excision or urethral diverticulum
4	8 9/12	Letter	Good general health; no breast trouble
5	8¼	Letter	Good general health; no breast trouble
6	3½	Letter from local physician	Died 3½ yr. after operation; visual hallucinations and depression for 1½ yr. prior to death; Jacksonian convulsions terminally; no necropsy
7	2	Examination	No recurrence or metastasis

seizures. Necropsy was not performed. Although this patient could, conceivably, have died of metastatic carcinoma, the duration of her illness and her age make us think more of a cerebrovascular disorder.

Comment

Although usually caused by a benign lesion, discharge from the nipple may be the earliest symptom of carcinoma of the breast. As an indication of the relative rarity of such instances, we could find only seven patients who had carcinoma of the breast in association with discharge from the nipple without a palpable mass in a 10-year span at the Clinic. During this time the diagnosis of carcinoma of the breast was made 3193 times.

The incidence of malignancy in breasts having a discharge but no palpable mass is difficult to determine, since many patients having discharge do not come to operation.

When only patients having bloody discharge are considered, it is possible to determine this incidence more accurately. At the Clinic operation is advised for almost all such patients. In an earlier study,[4] we found approximately 11 to 12 per year having operations (simple mastectomy) for bloody discharge without a palpable mass who had nonmalignant disease. This would be about 115 patients during a 10-year period. Six of the patients in our present study had carcinoma associated with a bloody discharge from the nipple without a palpable mass. This gives roughly an incidence of carcinoma of 5% in patients having bloody discharge without a palpable mass.

In patients having a nonbloody discharge, it is more difficult to determine the incidence of carcinoma, since many of these patients do not come to operation. During the four-year period of our previous study, 9 to 10 patients having nonmalignant disease came to operation per year because of nonbloody discharge from the nipple without any discrete, palpable mass. This would amount to about 95 during a 10-year period. In our present study, only one patient with a nonbloody discharge and no mass had carcinoma of the breast. This gives an incidence of carcinoma of roughly 1% for those coming to operation because of a nonbloody discharge without a palpable mass. When the nonsurgical cases are considered, the incidence is exceedingly low.

The prognosis for all these patients is better than for the usual patients having carcinoma of the breast. Only two patients had evidence of infiltrating carcinoma, and those having dissection of the axillary nodes had no evidence of metastasis.

On the basis of this and our previous study, we believe conservatism is warranted in the treatment of patients with discharge from the nipple and no palpable mass. One should attempt to excise the offending duct if it can be localized. The duct can often be identified by applying pressure to the breast in a radial manner (toward the nipple). Frequently fluid can be expressed only when no pressure has been applied to the breast for a number of days, giving a chance for secretions to accumulate in the ducts.

When it is not possible to localize the process or to determine the cause of the discharge by conservative surgical measures, simple mastectomy must be considered. Such a procedure is certainly justified in certain patients, for example, the elderly patient, the anxious patient, one

having had multiple biopsies on her breast, or one having carcinoma in her other breast. If simple mastectomy is not done, careful follow-up examinations of the patient are necessary.

In the presence of a mass, however, the primary concern is the mass and not the discharge. We do not here purport to minimize the significance of a mass in the presence of a discharge. In such cases, as when no discharge is present, treatment consists of biopsy of the mass; further treatment then depends on the nature of the lesion.

Summary

During the 10-year period of 1945 through 1954, we found seven cases of carcinoma of the breast associated with discharge from the nipple and no palpable mass. In six of the seven cases the discharge was bloody and in one serous. The incidence of carcinoma in those patients coming to operation with no palpable mass and with a bloody discharge was roughly 5%, whereas with a nonbloody discharge it was roughly 1%.

All seven patients showed comedocarcinoma histologically, two of these tumors giving evidence of infiltration. None of the four breasts treated by node dissection had metastasis to the lymph node.

Six of the patients had no evidence of recurrent disease at time of follow-up study: on five patients eight years or more after operation and on one two years after operation. The other patient, aged 82 years at death, died three and one-half years after operation with cerebral manifestations which probably were of vascular origin.

On the basis of our findings, we believe conservative surgical measures are warranted in the treatment of patients with a discharge from the nipple without a palpable mass. If no cause for the discharge can be found by conservative procedures, simple mastectomy may be justifiable.

Section of Publications, Mayo Clinic.

REFERENCES

1. Geschickter, C. F.: Diseases of the Breast, Ed. 2, Philadelphia, J. B. Lippincott Company, 1945.

2. Bell, E. T., cited by Campbell, O. J.: The Bleeding Nipple, Surgery 19:40-46 (Jan.) 1946.

3. Madalin, H. E.; Clagett, O. T., and McDonald, J. R.: Lesions of the Breast Associated with Discharge from the Nipple, Ann. Surg., to be published.

4. Madalin, H. E.: Lesions of the Breast Associated with Discharge from the Nipple: A Clinical and Pathologic Investigation of 100 Breasts, Thesis, Graduate School, University of Minnesota, 1956.

Collateral Circulation to the Heart by Means of Cardiopneumonopexy and Lingular Vein Ligation

CAPT. ROMAN J. KOWNACKI (MC), U. S. A. F.; VINCENT P. KOWNACKI, M.D.; ARTHUR J. KENNEL, M.D.; JOSEPH E. IMBRIGLIA, M.D., and WILLIAM L. MARTIN, M.D., Philadelphia

During the past three decades many experimental methods have been devised to provide collateral circulation to the heart, and Beck,[1] Hudson,[2] and Moritz[3] were instrumental in initiating this surge of enthusiasm. One method which has provided considerable interest has been the grafting onto the heart of vascular organs (with their blood supply preserved), and many different organs beside the lung have been used in this respect.[4-11] Lezuis,[12,13] in 1937, was the first to employ the lung in revascularizing the heart. He sutured the adjacent lung to the heart after creating a window in the pericardium and after placing acriflavine into the pericardium. He injected several of his specimens in vitro with radiopaque material into the pulmonary artery and demonstrated the collateral vessels from the lung to the heart. Carter,[14] in 1949, modified Lezuis' technique somewhat by employing asbestos paste in the pericardial sac and suturing the lingular lobe to the pericardium instead of the myocardium. Reimann and co-workers,[15,16] in 1950 and 1953, removed the pleura and epicardium with a razor before suturing the lung to the epicardium. Smith,[17] employed phenol to chemically abrade the epicardium; then a light poudrage of asbestos was used as "mucilage." Garamella and associates[18] employed segmental resections, using 30% acriflavine as the chemical abrasive. While this experiment was in progress, Kline et al.[19] reported, in an excellent paper, on the study of bronchial collateral circulation and myocardial revascularization by cardiopneumonopexy with ligation of the pulmonary artery within the pericardial sac. They employed silver nitrate as the caustic irritant. These investigators demonstrated that adjacent lung tissue could be grafted to the heart with beneficial results and that further research was warranted.

Cardiopneumonopexy has also been employed in humans. Carter[14] reported on using his technique in five patients, with improvement in four. Lezuis,[20] modifying his technique somewhat after placing acriflavine in the pericardial sac by suturing the lingula to the pericardium instead of to the myocardium, operated on two severe coronary artery cases and was successful. Smith[17] performed his procedure on eight patients, with encouraging results.

The ligation of the lingular vein, in addition to cardiopneumonopexy, was performed by us because of a number of interesting facts which have been discovered since 1911 by investigators who have studied the collateral circulation to the lung. In certain pathological conditions (emphysema, etc.) the venous collateral circulation of the lung may be quite significant.[21,22] Swan and Mulligan[23] successfully ligated the lobe veins in dogs, but ligation of the veins on one side was fatal in two animals. By employing penicillin in the early postoperative period, Hanlon and co-workers[24,25] reported a reduced mortality after ligation of the pulmonary veins on the right side and

Submitted for publication June 28, 1957.

From the Departments of Surgery and Pathology, Hahnemann Medical College and Hospital of Philadelphia.

Supported by a research grant from the Cardiovascular Institute of the Hahnemann Medical College and Hospital of Philadelphia.

a diminished incidence of positive blood cultures. Previously ligation of the pulmonary veins in dogs usually resulted in hemorrhage, pneumonitis, and thrombosis of the veins.[26-29] Hurwitz et al.,[30] employing penicillin and streptomycin in the early postoperative period, had no mortality with ligation of the major vein of the lung of 10 dogs. In addition, they demonstrated extensive collateral vessels, as well as enlargement of preexisting bronchial veins at the hilus. By catherization and bronchospirometric studies they demonstrated that the affected lungs were functional, in disagreement with previous investigators,[24,25] who contended that the affected lung was primarily a space-occupying structure, incapable of significant respiratory exchange. Their studies revealed an elevated content of oxygen in the azygos vein blood which approached the oxygen saturation level of arterial blood. This demonstrated that the extensive collateral circulation in the affected lungs is capable of transporting oxygen to the systemic veins and neighboring tissues.

Since pulmonary vein ligation does produce extensive collaterals to the affected lung, we were stimulated to employ not only cardiopneumonopexy but vein ligation as well. It remains to be demonstrated whether the lung, being a low-pressure system, serves as host or parasite to the myocardium, whose coronary flow is normally a high-pressure system.

Material and Method

Eighteen male and female mongrel dogs, weighing from 25 to 45 lb. (11 to 20 kg.), were anesthetized with intravenous pentobarbital sodium (Nembutal Sodium Veterinarian), 1 grain per 5 lb. (12 mg. per kilogram) of body weight. An endotracheal tube was inserted and connected to a positive-pressure neophore, which delivered 100% oxygen. The animal was placed on its right side, and the left chest was shaved of hair and prepared with pHisoderm (an detergent containing entsulfon, lanolin cholesterols, and petrolatum) and tincture of benzalkonium (Zephiran) chloride. A 10 to 12 cm. incision was made in the fifth interspace in the left chest, and a small rib retractor was inserted to ensure exposure. The middle, or lingular, lobe of the left lung was elevated, exposing its segmental vein, which was

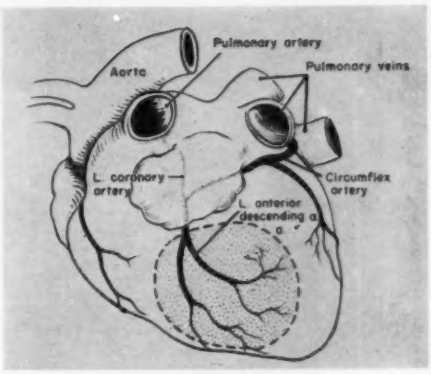


Fig. 1.—Drawing indicating area (shaded) of lung anastomosis and anatomy of left coronary artery.

doubly ligated with 000 black silk. The pericardium was then widely opened in a longitudinal manner, exposing the heart. A 30% acriflavine solution was then painted on the exposed surface of the heart, and the lingular lobe was sutured with interrupted 00000 black silk directly on the exposed surface of the heart in a circular manner on the area of heart muscle supplied by the anterior descending coronary artery (Fig. 1). The pericardium was left widely open. The retractor was removed; the lungs were expanded, and the wound was closed with No. 30 wire. Any residual air was aspirated with needle and syringe.

The second stage, which varied in intervals from 16 to 90 days, the animals were prepared as previously; the chest was opened, and the left auricular appendage was retracted laterally, exposing the left coronary, the circumflex, and the anterior descending arteries. At a point immediately adjacent to the origin of the circumflex artery, the anterior descending artery was doubly ligated with 000 silk and divided. Electrocardiographic tracings were obtained prior, during, and after the ligation. The incisions were closed as previously. Some animals required water seal drainage for a few hours because of air leakage. The dogs were then killed at varying intervals, with the sectioned heart and lung undergoing microscopic analysis.

Results

All the animals survived the first-stage operation without difficulty. In the second-stage operation, which consisted of ligation of the anterior descending coronary artery, the first three animals died as a result of faulty operative technique (hemorrhage, pneumothorax, etc.) and not of the ligation per se. All of the remaining 15 animals

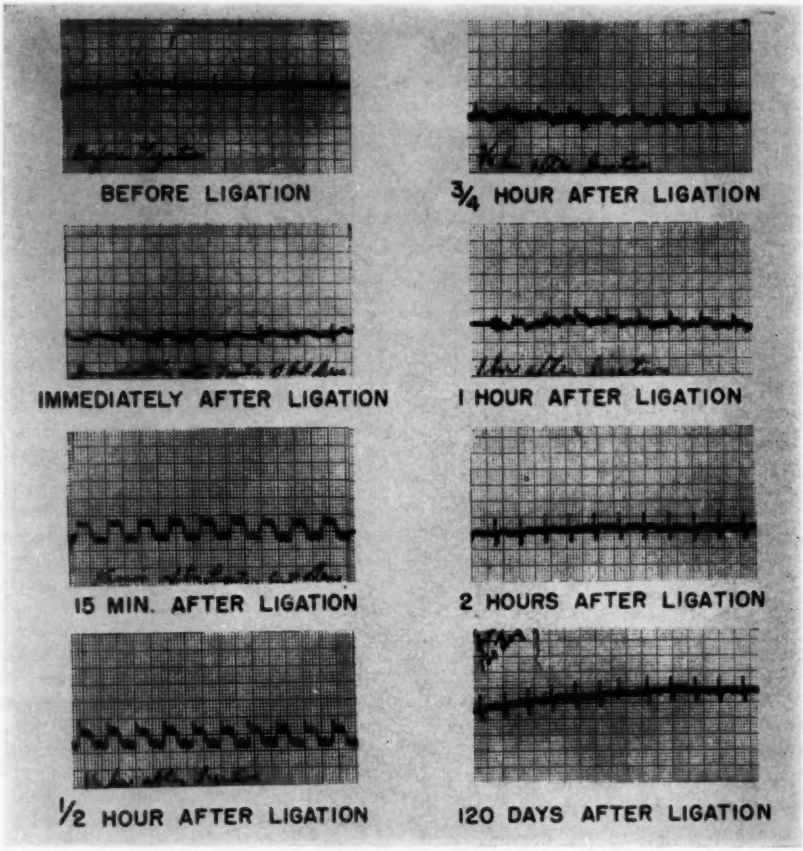


Fig. 2.—Electrocardiograms (Lead I) of dog 60 days after cardiopneumonopexy taken before and at various times after ligation of anterior descending coronary artery.

survived the ligation. The ligations were performed from 16 to 90 days after cardiopneumonopexy. In a control series, of 10 animals, we had a mortality of 90%.

Electrocardiograms were taken before ligation, immediately after ligation, and at variable intervals up to two hours after ligation of the anterior descending artery. A final electrocardiogram was taken prior to killing the animals.

It was evidenced that in four animals ligated 15 to 30 days after cardiopneumonopexy there developed a typical anterior-wall infarction pattern, which consisted of inverted T-waves, ST-segment elevations, and the appearance of a prominent Q-wave in Lead I and with reciprocal ST-segment depressions in Leads II and III.

Six dogs with ligations 30 to 60 days after cardiopneumonopexy showed ischemic patterns, which included inverted T-waves and ST-segment elevations. The Q-wave appeared in the majority of these animals, but it was of much smaller magnitude.

In the five animals ligated 60 to 90 days after cardiopneumonopexy the Q-wave did not appear in Lead I. However, all the animals' electrocardiograms showed ischemia, as evidenced by ST-segment elevations, which returned to the isoelectric line in two hours (Fig. 2). There was no evidence of severe arrhythmias in any of the animals.

The animals were then killed at varying intervals of from 30 to 150 days after cardiopneumonopexy, and the heart-lung specimens were examined microscopically.

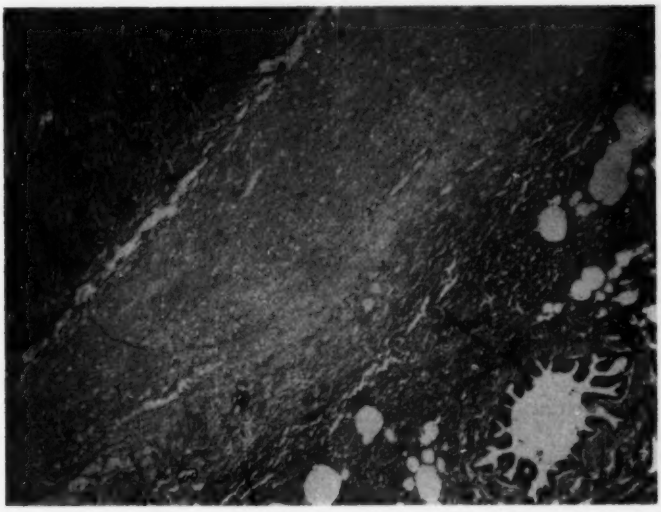


Fig. 3.—Photomicrograph of heart-lung union 30 days after cardiopneumonopexy.

Fig. 4.—Photomicrograph of heart-lung union 45 days after cardiopneumonopexy.

In the animals killed at 30 days (Fig. 3) there can be seen an early organized reaction between the heart and the lung. There is an inflammatory reaction on the periphery of the lung, and, in addition, a normal bronchus can be seen. Small, thin-walled blood vessels are beginning to form in the organized reaction between the heart and the lung.

In the animals killed at 45 days, with use of special staining techniques fibroconnective tissue is seen invading the myocardium (Fig. 4). Small, new-formed blood vessels can also be seen in this section. The inflammatory reaction has virtually subsided. Two silk sutures are also demonstrated.

In the animals killed at approximately 60 days there is histologically demonstrated a firm union between the lung and the heart (Fig. 5). In addition, there is complete replacement of the epicardium. Numerous blood vessels can be seen invading the myocardium. The inflammatory reaction noted on Figure 3 is absent.

In animals killed at 150 days there can be seen normal heart and lung tissue devoid of inflammatory reaction (Fig. 6). The

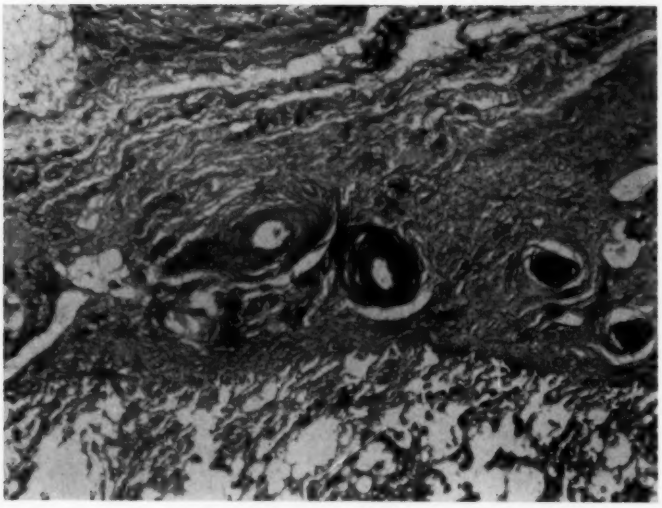


Fig. 5.—Photomicrograph of heart-lung union 60 days after cardiopneumonopexy.

area between the heart and the lung has been completely replaced by fibroconnective tissue stroma, in which are interlaced large collateral blood vessels.

Comment

Because of the anatomical proximity of the lung and because of its inherent vascularity, cardiopneumonopexy is an easy and effective means of providing a collateral blood supply to the heart. It is felt that the lung must be sutured snugly against the myocardium with a permanent-type suture and that the epicardium must be removed in some fashion prior to this procedure. We made no effort to close the pericardium, and this had no deleterious effect. We employed acriflavine because of its availability and continued to employ it in order to have uniformity in the experiment. We personally feel that possibly a more effective agent could be employed. Perhaps asbestos with phenol, combining adhesive qualities with the caustic removal of the epicardium, would be the more advantageous procedure. Acriflavine in a 30% solution does not appear to have enough abrading qualities, and, in addition, it is difficult to control the extent of application. The difficulty which some investigators encountered in finding

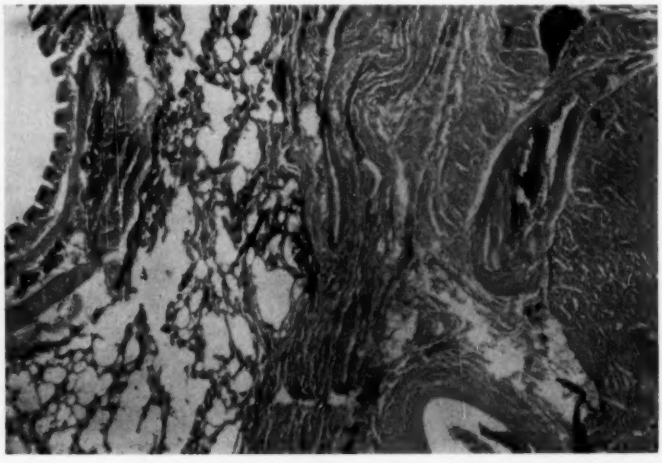


Fig. 6.—Photomicrograph of heart-lung union 150 days after cardiopneumonopexy.

the anterior coronary artery in the second stage was present only in the first four or five animals, and with one person performing the operation this identification became no problem, with experience. It was not necessary to tag the artery at the first operation. In some animals merely placing a ligature beneath the artery tended to produce an ischemic electrocardiographic pattern. We felt that this would add a variable factor to our experiment and consequently did no manipulation with the anterior coronary artery until the second-stage operation. At the second-stage operation we had no evidence of lung infarction. There was enlargement of the bronchial veins at the hilus, and new transpleural and terminal veins were evident. There were also venous channels within the pleural adhesions. The animals varied in the extent to which they formed adhesions. The lung appeared grossly to be a functioning unit. These findings confirm the results of Hurwitz et al.[30]

It is difficult to compare mortality figures with those of other investigators. In our small series, of 18 dogs, the first 3 animals died during or immediately after the second-stage procedure, and the remaining 15 animals survived. Obviously, increased experience with the procedure was reflected in increased survival. Carter [14] reported a 20% mortality in his experiments, but he sutured the lung to the pericardial sac instead of the heart. Smith [17] reported no mortality in a small series of 12 dogs after suture of the lung to the heart. The remaining investigators did not have large enough series to report significant mortality figures. We concur with the feeling of Smith [17] that the lung should be sutured to the heart in a snug fashion. Further work needs to be done in determining the optimal type of material to use in promoting lung-heart adherence.

Electrocardiographically, we feel we have demonstrated an ischemic myocardium, the pattern returning to normal presumably under the protection of the collateral blood flow from the lung. We feel that this is suggestive of directional blood flow from the lung to the heart, but further studies are being done along that line.

Histopathologically, there is to be seen chronologically, a definite revascularization pattern, consisting initially of an organized reaction between the heart and the lung, within which there are beginning tiny, thin-walled blood vessels. There is also a peripheral inflammatory reaction in the lung. Gradually, fibrous tissue with blood vessel collaterals develops in the zone between the heart and the lung. The epicardium then disappears, as well as the inflammatory reaction.

As evidenced electrocardiographically and histopathologically, for effective protection, i. e., against infarction, arrhythmias, etc., the entire process takes approximately 60 days by our method. Studies comparing heart-lung union with and without lingular vein ligation are in progress.

Summary and Conclusions

Individual pulmonary veins can be ligated without deleterious effects, and the ligation of the lingular vein can be done with impunity.

Cardiopneumonopexy with lingular vein ligation was demonstrated to have a protective effect not only in preventing death from anterior coronary artery ligation but also in preventing lethal arrhythmias.

We feel that, electrocardiographically and histopathologically, we have demonstrated a new-formed functional collateral circulation to the heart by cardiopneumonopexy and lingular vein ligation.

Dr. Raymond Truex, Professor and Head of the Department of Anatomy, Hahnemann Medical College and Hospital, gave advice and guidance in this study.

Division of Surgery, the Hahnemann Medical College and Hospital, 230 N. Broad St. (2).

REFERENCES

1. Beck, C. S., and Tichy, V. L.: Production of a Collateral Circulation to the Heart, Am. Heart J. 10:849, 1935.

2. Hudson, C. L.; Moritz, A. R., and Wearn, J. T.: Extracardiac Anastomoses of the Coronary Arteries, J. Exper. Med. 56:919, 1932.

3. Moritz, A. R.; Hudson, C. L., and Orgain, E. S.: Augmentation of the Extracardiac Anastomoses of the Coronary Arteries Through Pericardial Adhesions, J. Exper. Med. 59:927, 1932.

4. Beck, C. S.: A New Blood Supply to the Heart by Operation, Surg. Gynec. & Obst. 61: 407, 1935.

5. Feil, H., and Beck, C. S.: The Treatment of Coronary Sclerosis and Angina Pectoris by Producing New Blood Supply to Heart, J. A. M. A. 109:1781, 1937.

6. Beck, C. S.: The Coronary Operation, Am. Heart J. 22:539, 1941.

7. O'Shaughnessy, L.: An Experimental Method of Providing a Collateral Circulation to the Heart, Brit. J. Surg. 23:665, 1936.

8. Baronofsky, I. D.; Sprafka, J. L., and Noble, J. F.: Use of Intestinal Loops for Revascularization of the Heart, Circulation Res. 2:506, 1954.

9. Key, J. A.; Kergin, F. G.; Martineau, Y., and Leckey, R. G.: A Method of Supplementing the Coronary Circulation by a Jejunal Pedicle Graft, J. Thoracic Surg. 28:320, 1954.

10. Hannon, D. W., and Baronofsky, I. D.: A Comparison of Cardiojejunopexy with Other Methods of Revascularizing the Heart, Surgery 40:1111, 1956.

11. Neumann, C. G.; Moran, R. E.; Von Wedel, J.; Lord, J. W., Jr., and Hinton, J. W.: Reduction of Coronary Artery Blood Flow Preparatory to Revascularization of the Heart Via Pedicled Flap of Skin, Plast. & Reconstruct. Surg. 13:85, 1954.

12. Lezuis, A.: Die künstliche Blutversorgung des Herzmuskels, Arch. klin. Chir. 189:342, 1937.

13. Lezuis, A.: Die anatomischen und funktionellen Grundlagen der künstlichen Blutversorgung der Herzmuskels durch die Lunge bei Coronararterienverschluss, Arch. klin. Chir. 191: 101, 1938.

14. Carter, B. N.; Gall, E. A., and Wadsworth, C. L.: An Experimental Study of Collateral Coronary Circulation Produced by Cardiopneumonopexy, Surgery 25:489, 1949.

15. Reimann, D. L.; Cowley, R. A., and Raby, W. T.: An Attempt to Establish Collateral Circulation to the Myocardium: Preliminary Report, Bull. School Med. Univ. Maryland 35:1, 1950.

16. Reimann, D. L., and Mansberger, A. R., Jr.: A Technical Consideration of Cardiopneumopexy—Comparative Study, Bull. School Med. Univ. Maryland 38:118, 1953.

17. Smith, F. R.: Cardiopneumopexy: An Experimentally Effective Surgical Technic to Revascularize the Myocardium, West J. Surg. 63:66, 1955.

18. Garamella, J. J.; Hay, L. J.; George, V. P., and Jensen, N. K.: Modified Cardiopneumopexy Employing Segmental Resection: An Experimental Method with Directional Flow Studies, Surgery 39:574, 1956.

19. Kline, J. L.; Stern, H.; Bloomer, W. F., and Liebow, A. A.: The Application of an Induced Bronchial Collateral Circulation to the Coronary Arteries by Cardiopneumonopexy, Am. J. Path. 32:663, 1956.

20. Lezuis, A.: Die Behandlung der Angina pectoris und der Coronarinsuffizienz durch die Kardio-Pneumopexie, Arch. klin. Chir. 267:576, 1951.

21. Liebow, A. A.: The Bronchopulmonary Venous Collateral Circulation with Special Reference to Emphysema, Am. J. Path. 29:251, 1953.

22. Marchand, P.; Gilroy, J. C., and Wilson, V. H.: An Anatomical Study of the Bronchial Vascular System and Its Variations in Disease, Thorax 5:207, 1950.

23. Swan, H., and Mulligan, R. M.: An Experimental Study of the Effect of Ligation of Pulmonary Veins in the Dog, J. Thoracic Surg. 17:44, 1948.

24. Hanlon, C. R.; Sabiston, D. C., Jr., and Burke, D. R.: Experimental Pulmonary Venous Occlusion, J. Thoracic Surg. 24:190, 1952.

25. Wyatt, J. P.; Burke, D. R., and Hanlon, C. R.: Morphologic Study of Canine Lungs After Ligation of the Pulmonary Veins, Am. J. Path. 29:291, 1953.

26. Tiegel, M.: Operative Lungenstauung und deren Einfluss auf die Tuberculose, Arch. klin. Chir. 95:810, 1911.

27. Ameuille, P.; Lemoine, J. M., and Nouaille, J.: Suppléance circulatoire par les adhérences après ligature des veines pulmonaires, Ann. anat. path. 15:85, 1938.

28. Valkanyi, R.: Erzeugung einer venösen Stauung und ihre Wirkung auf Lungenlappen, als eine neue chirurgische Behandlungsart der Lungentuberkulose: I. Topographisch-anatomische und tierexperimentelle Studien, Arch. Klin. Chir. 182: 742, 1935; II. Durch die Lobovenoliglatur erzielte klinische Heilungsresultate, ibid. 191:504, 1938.

29. Mathes, M. E.; Holman, E., and Reichert, F. L.: A Study of the Bronchial, Pulmonary, and Lymphatic Circulation of the Lung Under Various Pathologic Conditions Experimentally Produced, J. Thoracic Surg. 1:339, 1932.

30. Hurwitz, A.; Calabresi, M.; Cooke, R. W., and Liebow, A. A.: An Experimental Study of the Venous Collateral Circulation of the Lung: Functional Observations, J. Thoracic Surg. 28: 241, 1954.

Hydatid Cyst of the Liver Producing Massive Gastrointestinal Hemorrhage

JAMES S. O'HARE, M.D., Baltimore

Echinococcosis, or hydatid disease, is uncommon in this country. In the majority of cases reported the disease was contracted abroad, the patients entering the United States as immigrants. Native cases are rare. Thirty-one cases have been reported with an apparent origin in the United States.[1] The disease is more prevalent in the state of Virginia than in other sections of the country, probably due to the high rate of infection in hogs in that state. The incidence of appearance of hydatid disease in this country may increase because of the popularity of travel abroad into countries where it may be endemic.

The disease is caused by the presence of the larval stage of Echinococcus granulosus (Taenia echinococcus), for which man is an intermediate host. The dog is the definitive host, and man acquires his infestation by eating contaminated food or through direct contact with infested dog excreta, thus ingesting the ova. The embryo is set free in the small intestine of man and, by penetrating the intestinal wall, reaches the vessels of the portal system and is carried to various organs of the body. After reaching its final resting place, it forms a larvated condition, the hydatid cyst. The larva localizes in the liver and lungs in 85% of the cases. Other organs involved are muscles, spleen, kidney, brain, and connective tissue.[2] A comprehensive description of the biology of the parasite has been presented by Arce.

Echinococcosis may produce a variety of symptoms, depending on the organ involved and the complications resulting from the presence of the cyst.[3] With hepatic involvement a frequent complaint is accidental discovery of the presence of a mass. In the female, signs and symptoms of a pelvic tumor may be present.[4] In countries where echinococcosis is prevalent, the presence of a tumor mass in the region of the liver may immediately arouse suspicion of the presence of an Echinococcus cyst. In this country such a diagnosis may not be entertained. The frequent presence of calcification in the wall of the cyst demonstrated by x-ray is an aid to diagnosis. Eosinophilia is suggestive of the presence of a hydatid cyst. The complement-fixation test is positive in over half of the cases. Casoni's intradermal test is the most diagnostic, reliable procedure. Susman states that a negative reaction indicates absence of the disease in 95% of the cases. The presence of a complicated cyst with intraperitoneal rupture and anaphylactic reaction, secondary infection with sepsis, or rupture into an adjacent structure, such as the bile ducts, can result in a variety of clinical manifestations. The case reported here is of interest because of its unusual symptomatology, and indicates that echinococcosis should be included in the differential diagnosis of gastrointestinal hemorrhage.

Submitted for publication June 14, 1957.

Report of a Case

A 63-year-old white woman was admitted to the hospital on July 16, 1956, with the chief complaints of melena and hematemesis. The patient had noticed the passage of black, tarry stools for one week preceding admission. She experienced no accompanying gastrointestinal symptoms. Twenty-four hours before admission there was an episode of copious vomiting of blood, promptly followed by headache, weakness, sweating, and nausea. There was no associated abdominal pain accompanying this bout of hematemesis. The patient had been in apparently good health without complaint before this present illness. There had been no recent weight loss.

The only previous hospitalization was in July, 1928. At that time the patient complained of a tender mass in the abdomen of two months' duration. Physical examination revealed the presence of a mass in the region of the gallbladder, movable and apparently attached to the liver. The admission diagnosis of carcinoma of the stomach or gumma of the liver was made. At operation, a mass, cystic in appearance, was located in the right lobe of the liver. The mass was nicked with a knife and thick fluid escaped. This was immediately absorbed by sponges previously placed in the abdomen. The mass was excised *in toto*. Pathological examination revealed a cyst filled with many small vesicles and fluid. A microscopic diagnosis of Echinococcus cyst was made. The patient's postoperative course was uneventful.

Physical examination at the time of admission revealed that the patient's pulse rate was 104 and her blood pressure 140/85. Significant physical findings consisted of a generalized pallor of the skin and the presence of a mass along the right costal margin, noted on abdominal palpation. This mass was nontender, firm, and smooth. Laboratory findings on admission were hemoglobin 48%; leukocytes 7700, with a normal differential; sedimentation rate 24; prothrombin activity 18% (26½ seconds).

A tentative diagnosis of bleeding peptic ulcer was made, and the patient was placed on a Sippy diet with antacids, and was given 1000 cc. of whole blood. On the morning following admission, laboratory studies revealed that the hemoglobin had risen to 68%. Other laboratory studies showed serum albumin 3.2 gm. per 100 ml., globulin 2.8 gm. per 100 ml., A/G ratio 1.1, total proteins 6 gm. per 100 ml., and cephalin flocculation 1+ in 24 hours and 3+ in 48 hours. On this morning, July 17, the patient had a recurrent hemorrhage, vomiting approximately 400 cc. of fresh blood in clots. The blood pressure fell to 90/50 and the pulse rose to 112 a minute. A fall in hemoglobin to 66% was noted. The patient was given whole blood and taken to the operating room.

At operation, through an upper right rectus incision, a smooth, rather thick-walled cystic mass was noted in the right lobe of the liver, presenting from its inferior surface and extending to the liver edge. The liver itself felt slightly thickened in consistency, and, although the surface was smooth, the edge was blunted. The other abdominal organs were found to be normal. The stomach and proximal duodenum were normal to palpation, no ulcer being noted. A gastrotomy was performed. The mucosa of the stomach and the proximal duodenum were palpated and inspected through this incision. Again, no source of bleeding was detected. The gastrotomy incision was closed, and attention was again directed to the liver and its contained cyst. By careful sharp and blunt dissection, a cleavage plane was located between the cyst and the liver substance, and the entire cyst was dissected free from the lobe of the liver. Bleeding from the liver surface was controlled by interrupted mattress sutures of chromic gut which approximated the liver edges and obliterated the cavity that remained after removal of the cyst. The abdomen was closed without drainage.

On pathological examination, the cyst was seen to measure 5.5 cm. in diameter, with a 1 mm., fibrous wall. The appearance of the wall suggested diffuse calcium content, and it contained calcified plaques. The contents of the cyst were a mixture of mucus and grayish, putty-like material. Microscopic examination revealed that the wall consisted of dense fibrous tissue with a zone of lymphocytes and a chitinous membrane. There was necrotic debris within the cyst itself. In the debris was found partially calcified scolices with calcified and uncalcified hooklets. The gross and microscopic appearance was that of spontaneous healing of an Echinococcus cyst. There was an excessive number of polypoid and binucleate cells in the adjacent liver tissues.

Pathological diagnosis was healed echinococcus cyst of the liver.

The patient's postoperative course was generally satisfactory. Further transfusions of whole blood were given until the hemoglobin rose to a satisfactory level. Parenteral vitamin K was administered daily. On July 24, the prothrombin activity had risen to 80%. The patient was discharged from the hospital on July 29, 1956.

Comment

The gastrointestinal hemorrhage in this case was due to hypoprothrombinemia, secondary to hepatic disease resulting from the presence of a hydatid cyst. Hepatic parenchymal disease, secondary to the presence of a hydatid cyst, has previously been recognized.[5] The proper correlation in this case of the patient's previous history of hydatid disease, the presence of a right upper quadrant mass, and hypoprothrombinemia could have led to a correct diagnosis before operation. Treatment directed toward the correction of the prothrombin deficiency would have eliminated the need for emergency surgery. Hypoprothrombinemia due to poor absorption of vitamin K or primary liver disease is occasionally seen in elderly patients and does not preclude the coexistence of a bleeding peptic ulcer. The trans-

fusion of significant quantities of fresh whole blood was considered sufficient to elevate an altered prothrombin time to safe levels. Faced with an elderly patient with recurrent massive hemorrhage following multiple transfusions and with the presumptive diagnosis of bleeding peptic ulcer, emergency surgery was considered a more conservative course to follow than continued medical treatment.

The only effective treatment for hydatid disease is surgical. A variety of operative procedures have been described. Regardless of the method used in the handling of the cyst itself, certain preliminary procedures are commonly considered essential. These consist of puncturing the cyst and evacuation of the parasite by suction through a trocar, careful cleansing of the cystic cavity, and preliminary formaldehyde treatment of the cyst contents with a 2% solution of formalin.[6]

In the absence of complication or infection, suture of the evacuated cyst and its adventitia without drainage can be utilized (Posadas' procedure). Marsupialization[7] may be employed for the uncomplicated cyst and is definitely indicated in the presence of infection. Omentoplasty[8] is a modification of Posadas' procedure and includes filling the evacuated cyst cavity with omentum. Posadas' technique has the objectional feature of occasional prolonged morbidity, due to fluid collection and secondary infection in the sac. Marsupialization is generally followed by a long period of morbidity with a persistent draining sinus. According to Neuman,[9] a superior procedure consists in removal of the cyst wall from its adventitia, followed by resection of the redundant portion to the level of the liver. Omentum is then sutured into the remaining liver cavity. His procedure results in an 8- to 12-day hospital stay, as compared with an average period of hospitalization of 37 days following marsupialization. Hepatic lobectomy has been resorted to in the presence of an extremely large cyst involving the entire lobe of the liver.[10] Intrabiliary rupture of a cyst may occur, producing common-duct obstruction. In such instances evacuation and drainage of the cyst cavity must be accomplished, followed by decompression of the biliary tree by cholecystectomy and choledochostomy with T-tube drainage.[11] Pedunculated cysts or cysts almost completely separate from the liver substance itself may be totally removed, the adventitia included. Since systemic manifestations from this disease are unusual, local surgical therapy is generally sufficient.

Summary

Echinococcosis, or hydatid disease, is uncommon in this country. A case with an unusual complication of massive gastrointestinal hemorrhage is presented. The various surgical procedures described for the treatment of Echinococcus cyst of the liver are outlined. Because of the absence of systemic manifestations in this disease, surgical treatment is highly successful.

104 W. Madison St. (1).

REFERENCES

1. Williams, C., Jr.: Echinococcus Disease, South. M. J. 46:1104 (Nov.) 1953.

2. Arce, J.: Hydatid Disease (Hydatidosis): Pathology and Treatment, Arch. Surg. 42:1 (Jan.) 1941.

3. Susman, M. P.: Hydatid Disease as It Affects the Thoracic Surgeon, J. Thoracic Surg. 26: 111 (Aug.) 1953.

4. Guz, A., and Lea, P. A. W.: Unusual Case of Hydatid Disease of the Peritoneum, Medical Memorandum, Brit. M. J. 1:385 (Feb. 18) 1956.

5. Hueston, J. T.: The Production of Liver Lobe Atrophy by Hydatid Cysts, Brit. J. Surg. 41:427 (Jan.) 1954.

6. Arce, J.: Hydatid Cyst of the Liver, Arch. Surg. 42:973 (June) 1941.

7. Barst, H. H.: Operative Procedure for Hydatid Disease of Liver, Brit. M. J. 1:1280 (June 2) 1956.

8. Kottakis, G., and Joannides, O.: Omentoplasty and Capsulectomy in the Treatment of Echinococcus Cysts of the Liver, J. Internat. Coll. Surgeons 23:729 (June) 1955.

9. Neuman, Z.: Surgical Treatment of Hydatid Cyst of the Liver, Postgrad. Med. 14:304 (Oct.) 1953.

10. Renner, R. R.; Roemer, F., and Telle, L. O.: Resection of Left Lobe of Liver for Echinococcus Cyst, Arch. Surg. 66:257 (Feb.) 1953.

11. Dagher, I. K., and Hovnanian, A. P.: Intrabiliary Rupture of Hydatid Cyst of the Liver, Ann. Surg. 141:263 (Feb.) 1955.

Venous Angiocardiographic Diagnosis of Acute Dissecting Hematoma of Aorta (Dissecting Aneurysm)

LOUIS A. SOLOFF, M.D.; JACOB ZATUCHNI, M.D.; HERBERT M. STAUFFER, M.D., and R. ROBERT TYSON, M.D., Philadelphia

Acute dissecting hematoma of the aortic wall is now potentially curable by surgery.[1] Without surgery more than one-third of persons so afflicted will die within 48 hours and about two-thirds within 10 days.[2] On the other hand, an exploratory operation may carry an even greater risk because of the many serious diseases which mimic this lesion clinically. What is urgently needed, therefore, is a safe procedure which can establish the diagnosis beyond question immediately after the onset of symptoms.

This paper describes three instances of acute dissecting hematoma to show that venous angiocardiography is a safe procedure which supplies a diagnostic picture. A fourth case illustrates the angiocardiographic pattern of a combination of an aneurysm of the aorta and healed dissecting hematoma.

Cases of Acute Dissecting Hematoma

CASE 1.—A 60-year-old Negro man was admitted to Temple University Hospital on March 31, 1957, because of persistent pain, which started abruptly the night before after a normal bowel movement. Pain that originated in the precordial area radiated first to the xiphoid region. From there, it swept around the left upper abdomen to the back, then into the right upper quadrant and finally was present diffusely over the abdomen and back. He was nauseated and dyspneic and perspired profusely. Magnesium sulfate U. S. P. (Epsom salt) taken for relief was promptly vomited.

He had had hypertension for 20 years. For the past year he had received digitalis and diuretics because of symptoms of cardiac insufficiency. He also gave a history of intolerance to fatty foods and had on occasion noticed light-colored stools and dark orange-colored urine. He also gave a history of intermittent claudication of the left leg, of many years' duration.

The blood pressure was 220/120 mm. Hg. Funduscopic examination disclosed changes consistent with chronic benign hypertension. The jugular veins were not distended. The heart was enlarged to the left. There were a slight lift in the left parasternal region and a heaving apical impulse in the sixth intercostal space at the left anterior axillary line. The aortic second sound was accentuated, followed by a slight blowing diastolic murmur. The rhythm was normal. Bilateral basilar crepitant rales were audible.

The abdominal wall was slightly distended, tender, and resistant to pressure. Peristalsis was decreased. The left femoral artery was barely palpable.

The laboratory studies were negative except for a white cell count of 12,600 per cubic millimeter, with 80% neutrophils.

The electrocardiogram revealed atrial and ventricular disease and anterior myocardial fibrosis.

A roentgenogram of the chest showed clear lung fields except for a linear density in the left lower lobe. The heart was enlarged. The superior mediastinum was widened and the aorta tortuous. A left paraspinal density was present, suggestive of a mediastinal effusion.

Although an acute dissecting hematoma of the aorta was suspected on clinical grounds, the radiologic findings were inadequate to establish this diagnosis with certainty.

Pain persisted and fever appeared. On April 4 venous angiocardiography disclosed a dissecting hematoma involving the transverse and descending thoracic aorta (Fig. 1). A linear translucent zone was seen separating the true lumen, which is compressed at the site of dissection, from the false lumen, the outer wall of which was ir-

Submitted for publication May 23, 1957.

From the Departments of Medicine, Radiology, and Surgery, Temple University School of Medicine and Hospital.

Clinical Professor of Medicine and Chief of the Division of Cardiology (Dr. Soloff); Assistant Professor of Medicine (Dr. Zatuchni); Professor of Radiology (Dr. Stauffer); Assistant Professor of Surgery (Dr. Tyson), Temple University School of Medicine and Hospital.

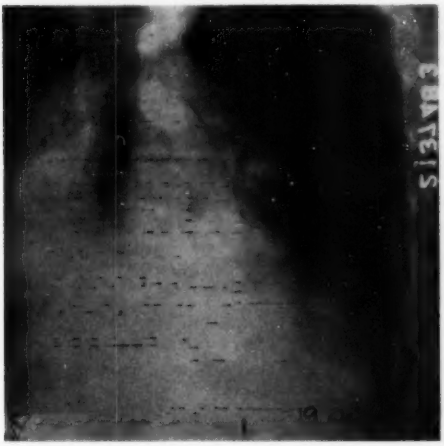


Fig. 1 (Case 1).—Angiocardiogram in slight left anterior oblique projection at 19 seconds after appearance of opacity in the right atrium. The left atrium, left ventricle, and aorta are opacified. There is enlargement of the left atrium and left ventricle. The ascending aorta is evidenced. The transverse and descending thoracic aorta show a double contour. The inner density, the true aortic lumen, is continuous with the main aortic channel and is narrowed. It is separated from the outer, less opaque density by a linear radiolucent zone, presumably representative of the intima, part of the media, and clot. The outer density, the false lumen, originates distal to the brachiocephalic vessels and extends below the diaphragm. The outer wall of the aorta in the region of dissection is irregular.

regular. The angiocardiographic circulation times were prolonged. The left atrium and left ventricle were enlarged.

Operation was performed on April 5. The left lateral hemithorax was entered and the seventh rib removed subperiosteally. The aorta was dissected free in the region of the sixth thoracic vertebra. The aorta was enlarged and felt thickened. Although the blood pressure was maintained, pulsations in the aorta could not be felt. Potts clamps were placed proximally and distally, and the aorta between the clamps was severed. A double lumen was found involving seven-eighths of the aortic circumference. The right outer layer of the aorta was very thin. One centimeter of the distal intima and media in the proximal aorta was resected. The distal false lumen was closed with a continuous suture, which was also used for end-to-end anastomosis of the aorta. The occluding clamps were removed 15 minutes after application. Nylon cloth was used to reinforce the aortic wall at the site of anastomosis.

Histological examination of the resected intima and media revealed fibrocollagenous material with a myxoid stroma. There were areas of cystic change. A mild inflammatory reaction was noticed. There were also a few foam-laden macrophages.

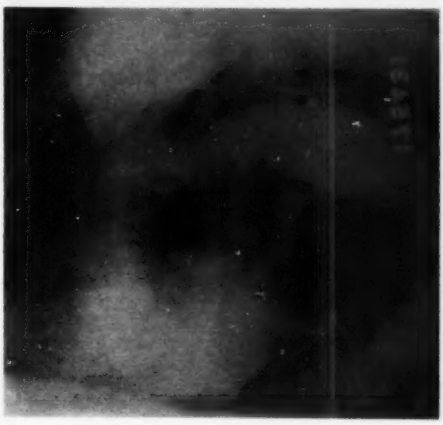
The postoperative course was essentially uneventful. Atrial fibrillation occurred on the fifth day but disappeared after increased digitalis and mercurial diuretics. The pain disappeared, and the right femoral artery pulsation was strong. The left femoral artery pulsation remained barely palpable. The patient was discharged on April 17.

Case 2.—A 78-year-old man was admitted to Temple University Hospital on April 9, 1957, because of chest pain, aggravated by any type of motion. Pain, originally associated with dyspnea, began eight days before admission.

The blood pressure was 180/110 mm. Hg. The femoral and popliteal arterial pulsations were strong, but the dorsalis pedis and posterior tibial arterial pulsations were absent. There were no signs of cardiac failure. The apex impulse was in the sixth intercostal space at the left anterior axillary line. The pulmonic second sound was louder than the aortic second sound, and both were decreased. An aortic systolic murmur of Grade 1 intensity and a left parasternal and mitral systolic murmur of Grade 2 intensity were present. Premature beats were present, with a ventricular rate of 90 per minute.

The electrocardiogram was consistent with healed myocardial infarction and left ventricular hypertrophy. Premature atrial beats were present.

Fig. 2 (Case 2).—Angiocardiogram in left lateral projection at 9.8 seconds after appearance of opacity in the right artium. The left atrium, left ventricle, and aorta are opacified, during ventricular systole. The left atrium is enlarged. The aorta is tortuous and increased in length. The ascending aorta is increased in diameter. The transverse aorta shows fusiform dilatation. A crescentic mass is adjacent to the transverse and descending thoracic aorta, representing the false lumen produced by the dissecting hematoma.



A roentgenogram of the chest showed slight left ventricular enlargement and a tortuous aorta with irregular dilatation of the transverse and descending thoracic aorta.

The laboratory studies were normal except for a white cell count of 19,500 per cubic millimeter, with 82% neutrophils.

A clinical diagnosis of acute dissecting hematoma of the aorta was entertained, and an angiocardiogram was done on the day of admission.

The superior vena cava was enlarged. The right atrium and ventricle were compressed. The pulmonary artery and its branches were displaced downward. The left atrium was slightly enlarged. The left ventricular wall was thickened. The angiocardiographic circulation times were slightly prolonged. The aorta was tortuous and elongated and showed various fusiform dilatations. A dissecting hematoma was seen originating immediately posterior to the brachiocephalic vessels and involved the transverse and descending thoracic aorta (Fig. 2).

Both the patient and his family refused permission for surgery.

Case 3.—A 55-year-old Negro woman was admitted to Temple University Hospital on Jan. 15, 1957, because of epigastric pain. She was apparently well until the day before admission, when, about six hours after eating pork, she experienced severe epigastric pain, radiating around the right side of her abdomen into the back. Pain was accompanied by bloating and dyspnea and was not relieved by walking. She therefore entered the receiving ward, where she promptly vomited.

Physical examination revealed tenderness in the left epigastric region. The blood pressure was 138/82 mm. Hg. The heart was enlarged to the left anterior axillary line in the seventh intercostal space. The aortic second sound equaled the pulmonic second sound, and the cardiac rhythm was normal. A few basilar crepitant rales were audible bilaterally.

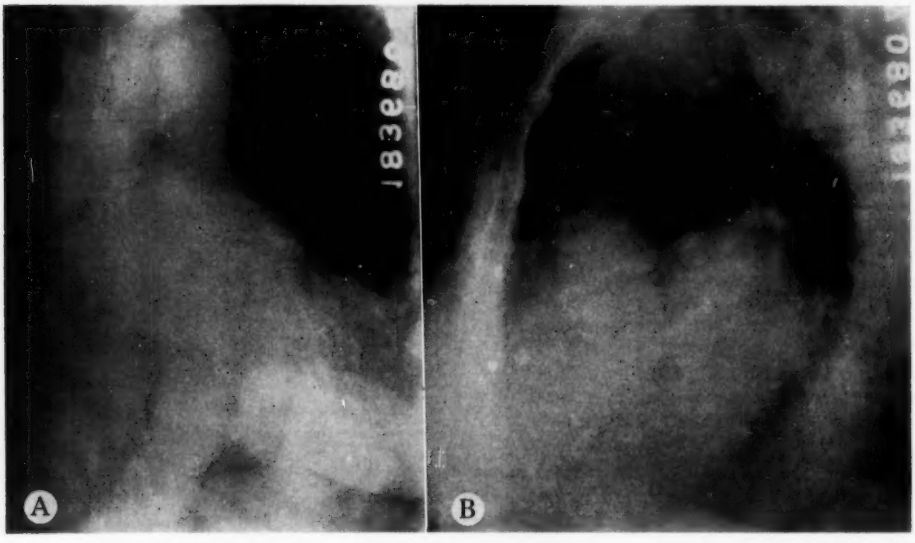
The admitting diagnosis was biliary colic, or possibly pancreatitis or a penetrating ulcer.

The laboratory studies were essentially normal except for a nonfunctioning gallbladder. Three days later a left pleural effusion was detected and confirmed by roentgenography.

Thoracentesis resulted in 200 ml. of straw-colored sterile fluid. Bronchoscopy revealed external compression of the left main bronchus and mucosal congestion. The tuberculin test was positive, but sputum examination was negative for acid-fast bacilli. An antituberculous regimen was instituted.

However, because of the persistence of pain, fever, and the left pleural effusion, an angiocardiogram was taken on Jan. 29, and clearly showed a

Fig. 3 (Case 3).—Simultaneous angiocardiograms in anterior (*A*) and left lateral (*B*) projections at 9.8 seconds after appearance of opacity in the right atrium. The left atrium, left ventricle, and aorta are opacified. The left atrium and left ventricle are greatly enlarged. The ascending aorta is increased in diameter. There is calcification of the arch. A mass of less opacity than the main aortic channel is seen adjacent to the left, superior, and posterior borders of the "aorta." It begins at the take-off of the brachiocephalic vessels and ends at the level of the left hemidiaphragm. The true aortic lumen shows greater compression arteroposteriorly than from side to side. Separating the true and false lumens is a linear radiolucent zone.



dissecting hematoma of the transverse and descending aorta, enlargement of the left atrium and left ventricle, and normal circulation times (Fig. 3).

Permission for surgery was again not obtained.

Comment

Although the clinical syndromes of acute dissecting hematoma of the aortic wall have been well documented, the syndromes are not definitive, and the incidence of correct clinical diagnosis in any specific series remains disappointingly low. Thus, 41% is the highest recorded incidence of correct diagnosis in any series,[3] and in one series not a single instance was correctly diagnosed.[4] The equally important incidence of a false diagnosis of this lesion is unknown.

The conventional roentgenographic criteria for the diagnosis of acute dissecting hematoma of the aortic wall have not lived up to the expectations originally raised by Davy and Gates[5] and Wood, Pendergrass, and Ostrum.[6] Difficulty in diagnosis arises primarily because the transverse aorta courses upward and to the left, as well as backward. This course is exaggerated in arteriosclerosis and frequently in aneurysm of the aorta. The result is an apparent double aortic knob, which originally formed the basis of a diagnosis of dissecting hematoma.

Inspection of a pathologic specimen suggests that the contrast medium-filled aorta should give a specific picture. Robb[7] was the first to describe this pathognomonic pattern, in a case of chronic or healed (asymptomatic) dissecting hematoma of the aortic wall. A similar case was described by Golden and Weens[8] and formed a part of a discussion by Paullin and James.[9] Dotter and Steinberg[10] have two similar illustrations in their book. It is, therefore, surprising that venous angiocardiography has been completely ignored as a means of establishing the diagnosis of healed dissection of the aorta. Thus, Burchell,[11] well aware of these reports, states that little has been added to the roentgenologic findings since the study by Wood, Pendergrass, and Ostrum in 1932.

It is easier to understand the neglect of this procedure in acute dissecting hematoma of the aorta. The attitude of the medical profession is well expressed by Levinson, Edmeades, and Griffith,[2] who state:

> Since the patient in the acute stage of suspected dissecting aneurysm should not be moved and should be spared any unnecessary activity the x-ray study at this time should be limited to a bedside examination. . . . Also the x-ray findings will hardly affect the therapeutic approach.

It is important, when discussing the mortality and morbidity of angiocardiography, that distinction be made between studies in children and those in adults and between selective and venous angiocardiography. We have performed over 300 venous angiocardiographic studies in adults with a variety of serious pulmonary and cardiac disorders, including cardiac failure. Many of our studies have been done on outpatients. We have had no deaths. Morbidity is limited to a rare transient urticaria and an infrequent occurrence of trival thrombophlebitis at the site of injection. In one of our earliest patients, sloughing of skin at the site of injection occurred, due to extravasation of contrast substance. We have had no untoward cardiac or aortic reaction. It was because of this favorable experience that we employed venous angiocardiography as a diagnostic procedure in patients clinically suspected of having acute dissecting hematoma. We were delighted to find, as we anticipated, that there was no untoward cardias or aortic reaction and that the studies were diagnostic. Our technique has been described elsewhere.[12] If a biplane apparatus is not available, the lateral projection is more favorable for visualizing the diagnostic pattern.

The diagnostic angiocardiographic pattern consist of visualizing two aortic lumens, a true one and a false one. The densely opacified main aortic channel gives rise at the site of dissection to two lumens, usually separated by a thin layer of radiolucency. The true lumen has smooth borders and is as densely opacified as the main aortic channel, but in the absence of aneurysmal dilatation

is usually narrower. This narrowing is usually greater from front to back than from side to side.

The false lumen is represented by a mass which surrounds the true lumen and compresses it variably. The opacification of the mass is usually slight because of minimal or no concentration of contrast substance within it. The outer border of the false lumen is usually parallel to or more convex than its inner border. The false lumen may be uniform in width or be convex outward, with the greatest width proximally, depending upon the degree of dissection and the integrity of the outer aortic wall. Tapering may occur at one or both ends, depending upon the extent of dissection.

Tapering with final disappearance of the false lumen distally may signify reentry of the false lumen into the true lumen or blind termination of the dissection. Tapering proximally does not represent the site of the intimal tear, which is not visualized by venous angiocardiography. An extremely rapid exposure time may perhaps visualize contrast substance passing from the true to the false lumen. With our present technique, it appears likely that the site of intimal tear, if present, is close to the origin of the crescentic mass or the site of its greatest width, although the possibility that this region may simply be the site of greatest weakening of the aortic wall cannot be excluded.

Thus, for instance, with atherosclerosis, irregular widening of the false lumen may be seen. If irregularity occurs in a localized region, a dissecting hematoma within an aortic aneurysm is likely to be present, as illustrated in the following case.

CASE 4.—A 73-year-old man was admitted to the Episcopal Hospital on Oct. 11, 1953, because of inability to speak and of involuntary movements of his body, first noticed upon wakening on the day of admission.

He had been hospitalized several weeks before because of shortness of breath and swelling of his ankles. Sine then, he had not been well and had experienced increasing fatigue, and particularly weakness of his legs, so that he could hardly stand. Two days before admission he noted swelling of his left arm, and on the day before admission inability to stand.

Examination revealed twitching of his face and upper extremities. The blood pressure was 230/130 mm. Hg. The fundal findings were consistent with benign hypertension. The neurologic examination was not revealing, nor was an x-ray of the skull or lumbar puncture except for a pressure of 410 mm. of fluid. The blood urea nitrogen was 55 mg. per 100 ml.

The apex impulse was in the sixth intercostal space at the left anterior axillary line. A loud precordial systolic murmur was heard best over the apex and xiphoid. The heart sounds were not audible. There was slight pitting edema of the ankles and of the left hand. The left dorsalis pedis arterial pulsation was decreased.

The electrocardiogram was consistent with left ventricular hypertrophy and digitalis effect.

A roentgenogram of the chest confirmed the clinical diagnosis of left ventricular enlargement and also revealed a saccular aneurysm of the posterior portion of the arch.

An angiocardiogram showed in addition a dissecting hematoma (Fig. 4).

During his hospital stay, he had spells of confusion, one episode of unconsciousness, and two attacks of pulmonary edema, dying soon after the second attack.

Fig. 4 (Case 4).—Angiocardiogram in the left anterior oblique projection. The left atrium, left ventricle, and aorta are opacified. Note the narrowed arch and the saccular aneurysm beyond. Note also the thin mass parallel to the ascending aorta and dispersal of contrast substance in the descending aorta.

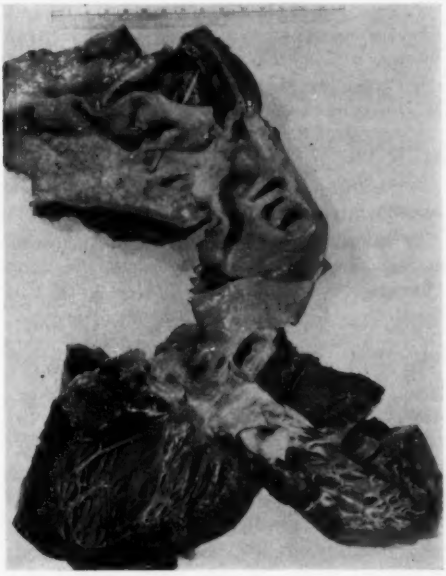


Fig. 5 (Case 4).—Heart and aorta at necropsy. There are left ventricular hypertrophy and aortic stenosis. Note the longitudinal cut above the intimal tear. A double aortic channel is seen. Note also at the place where a toothpick has been inserted into another intimal opening, an aneurysm of the outer aortic wall with laminated clot.

Necropsy (done by Dr. W. P. Belk on Nov. 27, 1953) showed an edematous brain with regions of softening in the right frontoparietal and left frontal lobes, sclerotic vessels of the circle of Willis, and contracted, granular kidneys. Each pleural cavity contained 600 ml. of amber fluid.

The heart with its attached aneurysm weighed 600 gm. (Fig. 5). The left ventricle was hypertrophied and free of infarcts. The coronary arteries were patent. The aortic orifice, guarded by an atheromatous valve, admitted only one finger.

Three and one-half centimeters above the aortic valve was a slit-like opening of the intima of the aorta, lined by smooth endothelized tissue. This opening readily admitted a pair of scissors and led into a dissecting hematoma, which encircled three-fourths of the aorta and terminated at the celiac axis, where it reentered the main aortic channel. Distal to the brachiocephalic vessels was an aneurysm of the outer wall of the aorta, containing laminated clot. Here, too, was a smooth, endothelized opening into the main aortic channel.

The anatomic diagnosis was aortic stenosis, aneurysm of the aorta, chronic dissecting hematoma of the aorta, cardiac enlargement with left ventricular hypertrophy, chronic nephrosclerosis, and encephalomalacia.

It is the presence of this "soft-tissue" density adjacent to the "aorta" which makes it difficult to differentiate by conventional roentgenography a dissecting hematoma and an aneurysm. The difference is easily resolved by angiocardiography, for with saccular and fusiform aneurysms there are, respectively, abrupt and gradual increases in size of the aortic lumen of localized extent with equal or greater opacification than the aorta.[13] Moreover, surrounding "soft-tissue" density either is not found or, if present, is uniform in width and usually thin.[13] In contrast, in dissecting hematoma, the surrounding density is less opaque than the main aortic channel and has considerable width, which is not uniform.

Once a definitive diagnosis is established by venous angiocardiography, one can then proceed with confidence to attempt to apply the procedure proposed by DeBakey, Cooley, and Creech[1] for its surgical correction. They adopted nature's method of healing, in which spontaneous reentry of the dissected passage at some distal point in the aorta permits restoration of peripheral circulation and, by abolishing the increasing tension in the outer wall, prevents its rupture. They reported recovery and gratifying results in 13 of 16 cases. One of us (R. T. R.) has performed the operation in two cases. One with a successful outcome is reported in this study. The other patient died on the operating table because of proximal extension of dissection with rupture into the pericardial cavity. Death of this sort can perhaps be prevented in the future with extracorporeal circulatory techniques, which permit repair of the ascending aorta.

Summary

Venous angiocardiography is a safe procedure in the presence of acute dissecting hematoma of the aorta.

The diagnostic venous angiocardiographic pattern of acute dissecting hematoma is described.

The variation of this pattern produced by an associated aneurysm is also described.

Division of Cardiology, Temple University Medical Center (Dr. Soloff).

REFERENCES

1. DeBakey, M. E.; Cooley, D. A., and Creech, O., Jr.: Aneurysm of the Aorta Treated by Resection, J. A. M. A. 163:1439, 1957.

2. Levinson, D. C.; Edmeades, D. T., and Griffith, G. C.: Dissecting Aneurysm of the Aorta: Its Clinical, Electrocardiographic and Laboratory Features; a Report of 58 Autopsied Cases, Circulation 1:360, 1950.

3. David, P.; McPeak, E. M.; Vivas-Salas, E., and White, P. D.: Dissecting Aneurysm of the Aorta, Ann. Int. Med. 27:405, 1947.

4. Emery, W. F.: Dissecting Aneurysms with an Account of 24 Cases, M. J. Australia 2:690, 1946.

5. Davy, H., and Gates, N.: A Case of Dissecting Aneurysm of the Aorta, Brit. M. J. 1:471, 1922.

6. Wood, F. C.; Pendergrass, E. P., and Ostrum, H. W.: Dissecting Aneurysm of the Aorta with Special Reference to Its Roentgenographic Features, Am. J. Roentgenol. 28:437, 1932.

7. Robb, G. P., Editor: Atlas of Abnormal Angiocardiography, Washington, D. C., Army Institute of Pathology, 1946.

8. Golden, A., and Weens, H. S.: The Diagnosis of Dissecting Aneurysm of the Aorta by Angiocardiography: Report of a Case, Am. Heart J. 37:114, 1949.

9. Paullin, J. E., and James, D. F.: Dissecting Aneurysm of Aorta, Postgrad. Med. 4:291, 1948.

10. Dotter, C. T., and Steinberg, I.: Angiocardiography, Annals of Roentgenology, Series of Monographic Atlases, Vol. XX, New York, Paul B. Hoeber, Inc. (Medical Book Department of Harper & Bros., 1951, Figs. 128 and 129.

11. Burchell, H. B.: Aortic Dissection (Dissecting Hematoma; Dissecting Aneurysm of the Aorta), Circulation 12:1068, 1955.

12. Soloff, L. A.; Zatuchni, J.; Stauffer, H. M., and Kelly, E. W.: Angiocardiographic Observations of Intracardiac Flow in the Normal and in Mitral Stenosis, Circulation 13:334, 1956.

13. Steinberg, I.: Diagnosis of Arteriosclerotic Aneurysms of the Thoracic Aorta: Report of 6 Cases, Ann. Int. Med. 46:218, 1957.

Pain Control Following Hemorrhoidectomy

HOWARD D. TRIMPI, M.D., and GUY L. KRATZER, M.D., Allentown, Pa.

Among the commoner and more beneficial surgical procedures of this century there is none that consistently produces greater postoperative pain than hemorrhoidectomy. Despite improved techniques with carefully performed dissections and well-placed sutures, postoperative pain control is by no means simple. We have employed most of the so-called long-lasting injectable anesthetic agents in the perianal tissues of large numbers of patients, only to give up this approach because of complications and the frequent finding that in most cases narcotics were necessary after all.

In selecting injectable agents for early postoperative pain control dihydromorphinone (Dilaudid) hydrochloride U. S. P. seemed to offer less side-reactions than did morphine. With the advent of meperidine (Demerol) hydrochloride still more side-reactions were eliminated; yet dihydromorphinone was not discarded from our armamentarium because in certain patients it gave greater pain relief than did meperidine. Seeking to find a pain suppressant that would provide the needed sustained relief with minimal side-reactions, levorphanol (Levo-Dromoran) tartrate was tried. Preliminary comparisons seemed significant; so a study was proposed by which the three drugs—dihydromorphinone, meperidine, and levorphanol—could be more accurately compared.

Plan of Study

Although pain threshold varies from patient to patient, the amount of pain experienced after hemorrhoidectomy is generally proportional to the amount of denudation of anoderm and perianal skin. To keep to a minimum as many variable factors as possible, a standard operation was chosen; therefore only patients having complete anorectoplasty were selected for comparisons. A total of 150 patients were studied. In each patient a complete circumferential removal of internal and external hemorrhoidal plexuses was performed. In the anterior and posterior commissures of the anus sliding skin flaps were elevated and then approximated to mucous membrane to form a new anorectal line. Laterally, drainage wounds were allowed to remain and mucous membrane was approximated to superficial sphincter muscle fibers. In each patient between 20 and 30 interrupted sutures of 0 and 00 plain gut were employed to reconstruct the anorectal line. We considered these operations to be more extensive, and therefore more likely to cause greater pain, than the usual hemorrhoidectomy.

Postoperatively each patient received similar care in that dressings were removed the morning following surgery and hot sitz baths begun. Full diets were given the day after surgery, and, in order to encourage early bowel movements, a bulk laxative was administered three times daily. If no bowel movement occurred before the third postoperative day magnesia magma U. S. P. was ordered, to be followed by an isotonic saline enema on the third postoperative day. Most patients were discharged on their third or fourth postoperative day.

There were no instances of hemorrhage, abscess formation, or other complication that might increase morbidity and pain.

The series of 150 patients was divided so that 50 patients received dihydromorphinone postoperatively, 50 patients received meperidine, and 50 received levorphanol tartrate in a random sequence. Dosages were

Submitted for publication June 21, 1957.

TABLE 1.—*Comparative Doses Based on Weight*

Drug	Dose, Mg.	
Dihydromorphinone	2	Under 130 lb.
Meperidine	75	
Levorphanol	2	
Dihydromorphinone	3	131–160 lb.
Meperidine	100	
Levorphanol	3	
Dihydromorphinone	4	Over 160 lb.
Meperidine	125–150	
Levorphanol	4	

based on body weight. A comparison table of dosages was worked out through preliminary trials using the three drugs (Table 1). Doses of less than 2 mg. of dihydromorphinone hydrochloride, 75 mg. of meperidine hydrochloride, or 2 mg. of levorphanol were discarded, since they proved ineffective in the immediate postoperative periods. Doses greater than 4 mg. of dihydromorphinone hydrochloride, 150 mg. of meperidine hydrochloride, and 4 mg. of levorphanol tartrate were unnecessary.

χ^2-Techniques applied to distributions of sexes showed the three groups to be similar populations within the limits of chance:

Dihydromorphinone	$\chi^2=0.08$	$P=0.775$
Meperidine	$\chi^2=0.72$	$P=0.4$
Levorphanol	$\chi^2=0.35$	$P=0.507$

Inspection of age and weight distributions indicated only slight dissimilarities (Table 2).

Pain Control

In evaluating postoperative pain in this study, the investigators relied on the patient's complaint as to onset of pain. Narcotic injections were administered promptly. By questioning each patient, the investigators determined the amount or degree of relief obtained, the time elapsing between administering the dose and relief, and the duration of relief. Degrees or amount of relief were given values of 1 to 4. Minimal relief was thus noted as 1, whereas complete relief was given the value of 4. The average degree of relief per dose among the 150 patients is shown in Table 3. Graph 1 shows the average degree of relief at different days after operation.

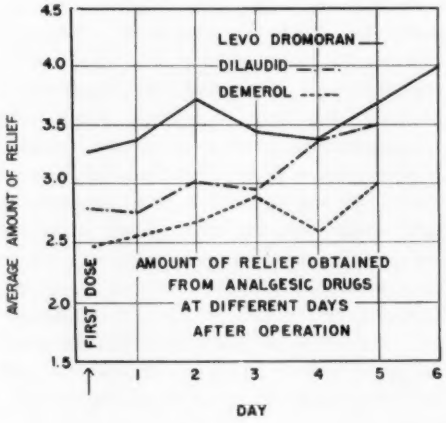
The times to obtain pain relief, for all doses of medication, are compared in Table

TABLE 2.—*Sex, Age, and Weight Distributions*

	Dihydromorphinone	Meperidine	Levorphanol
Sex			
Male	28	26	27
Female	22	24	23
Age, Yr.			
Under 20	0	2	1
21–40	25	24	17
41–60	18	22	25
Over 60	7	2	7
Weight, lb.			
Under 130	9	13	11
131–160	18	25	24
Over 160	23	12	15

TABLE 3.—*Average Degree of Relief per Dose, Graded as 1 to 4*

	Degrees of Relief
Dihydromorphinone	2.78
Meperidine	2.48
Levorphanol	3.26
	Average Dose Administered, Mg.
Dihydromorphinone	3.40
Meperidine	117
Levorphanol	3.48



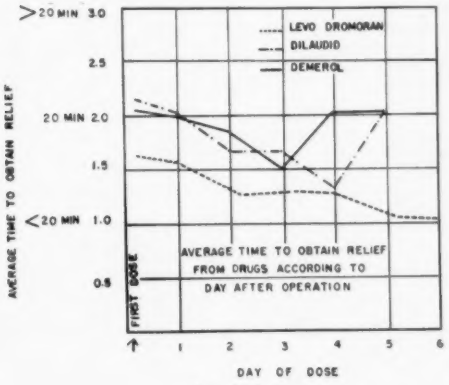
Graph 1

TABLE 4.—*Time to Pain Relief. Total Doses Given to All Patients*

Time to Relief	Dihydromorphinone	Meperidine	Levorphanol
Under 20 min.	53	81	90
At 20 min.	76	63	29
Over 20 min.	47	60	17
Total doses given to all patients	176	204	136

4 and illustrated in Graph 2. Since pain was found to be most intense soon after operation, comparison of the time to pain relief from first dose were of importance (Table 5).

A few patients required no other injection than that given within six hours after surgery. Most patients received medication for the first two days postoperatively; a few received medications daily until the sixth postoperative day (Table 6).



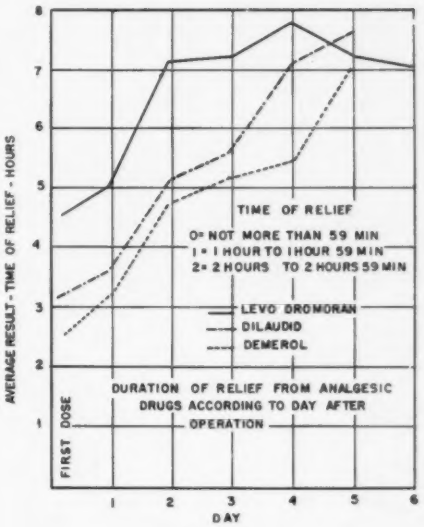
Graph 2

TABLE 5.—*Time to Pain Relief, First Dose Only*

Time to Relief	No. of Patients Receiving		
	Dihydromorphinone	Meperidine	Levorphanol
Under 20 min.	8	16	27
At 20 min.	27	15	15
Over 20 min.	15	19	8
Total No. of patients	50	50	50

TABLE 6.—*Numbers of Injections Given Patients*

No. of Doses	Dihydromorphinone	Meperidine	Levorphanol
1	10	9	16
2	12	10	14
3	8	8	7
4	5	4	4
5	4	2	3
6	5	8	3
7	3	1	2
8	2	4	1
9	0	3	0
10	0	0	0
11	1	1	0
Total injections needed	176	204	136
Total patients in group	50	50	50
Average injections per patient	3.5	4.0	2.7



Graph 3

The duration of relief was defined as time elapsing between giving of medication and return of pain. Values were accorded thus: duration of relief of less than 1 hour, 0; 1 hour to 1 hour 59 minutes, 1; 2 hours to 2 hours 59 minutes, 2, etc., to 10 hours or over, 10. Using these values, a graph was then constructed to illustrate the average result of the duration of relief (Graph 3).

The average relief, in hours, for the first dose only was as follows:

	Hours
Dihydromorphinone	3.22
Meperidine	2.56
Levorphanol	4.73

The average duration of relief, in hours, for all doses was as follows:

	Hours
Dihydromorphinone	4.33
Meperidine	3.95
Levorphanol	5.71

Side-Reactions

Untoward side-reactions other than nausea, vomiting, and constipation were not observed after any injection of any of the medications. Nausea occurred in 39 of the 150 patients studied. Grades 1 and 2 were given for severity of nausea without vomit-

TABLE 7.—*Nausea*

Grade	Dihydromorphinone	Meperidine	Levorphanol
4	5	1	0
3	3	5	8
2	8	0	5
1	2	1	1
None	32	43	36

ing. Grade 3 included patients with vomiting whose symptoms diminished by the second postoperative day. If nausea and vomiting persisted beyond the second day, Grade 4 was recorded. The results are noted in Table 7.

Constipation was a fairly common finding. All patients received a bulk laxative beginning on the first postoperative day. If bowel movement occurred by the end of the second postoperative day, constipation was felt not to be present. Grade I was applied to those having movements on the third postoperative day. Grade II included those who required magnesia magma U. S. P. in addition to the bulk laxative. Grade III included patients requiring enemas in addition to bulk laxative and magnesia magma U. S. P. Grade IV was reserved for patients requiring more than one enema or for patients having constipation persisting to the end of the fourth postoperative day.

TABLE 8.—*Constipation*

Grade	Dihydromorphinone	Meperidine	Levorphanol
4	5	3	1
3	11	9	6
2	6	2	0
1	10	18	2
	18	18	41

Table 8 indicates the findings with regard to constipation.

Comment

Levorphanol was found superior to dihydromorphinone and meperidine with regard to promptness of action, amount of pain relief, and duration of pain relief. Of interest is the fact that the least number of injections required for pain relief was in the group of patients receiving levorphanol tartrate. Second- and third-postoperative-day injections were needed less for levorphanol than for the other drugs. Comparisons of the first dose, first day, second day, and third day by measurements of time between administration of the medications to time of relief, the amount of relief, and duration or extent of relief were of particular significance. The data for the fourth, fifth, and sixth days are too limited to have any but indicative value.

Of the 50 patients who received levorphenol, 74% were given three doses or less for pain suppression during their entire postoperative period (Table 6). Most of these doses were in the first 24 hours after operation. This lends support to the observation that if pain is once completely controlled in the immediate postoperative period it becomes better tolerated and less of a problem in the succeeding days. On the other hand, if pain is poorly controlled at first, it is likely that the patient will continue to require medication for a much longer period, with prolongation of his hospital stay.

The only untoward side-reactions evident in the 150 patients studied that could be partially or totally attributed to the pain suppressants were nausea and constipation. There were no instances of blood pressure fall, respiratory depression, drug addiction, pruritus, or other complication. Undoubtedly, the operative procedure itself contributed to both nausea and constipation in many patients; however, there were differences in the groups, as noted in Table 7 and Table 8. Nausea was slightly less in the meperidine group than the others, whereas constipation was markedly less in the levorphanol group.

Of particular interest is the variation in the time needed to obtain pain relief, the degree of pain relief, and the duration of pain relief in relation to time following the operation. All improved as the analgesics were given in later days following operation. While there was considerable individual variation, the averages for these results were consistent and were statistically significant. This was probably due to healing of the

operative wound, with resultant lessening of pain.

Summary and Conclusions

A series of 150 patients divided into three randomized groups of 50 each were studied to determine the efficacy of dihydromorphinone (Dilaudid) hydrochloride, meperidine (Demerol) hydrochloride, and levorphanol and (Levo-Dromoran) tartrate for the control of pain following standardized extensive hemorrhoidectomies.

Levorphenol provided faster relief of pain, greater pain relief, and longer duration of pain relief per dose than did dihydromorphinone or meperidine under the conditions and dosages of the study.

Dihydromorphinone was superior to meperidine in degree and duration of pain relief. Nausea was least evident in the meperidine group; constipation was least evident in patients receiving levorphenol.

1447 Hamilton St.

Carcinoma Arising in Sebaceous Cysts

JACK W. WELCH, M.D., Halstead, Kan.

The development of carcinoma in sebaceous cysts has been reported rather infrequently in the literature, and most of the studies are either small in number or reports of single cases. Several larger series [2,4,5,12,15] have been reported either as a collection of consecutive cases or as a compilation from the literature. Our series of cases, while neither large nor small, contains several singular features which would seem to merit publication.

Incidence of Malignancy

The incidence of malignant change in sebaceous cysts cited in the various reports in the literature ranges from a high of 9.2%, recorded by Bishop,[2] to a low of 0.033%, given by Collins,[5] although the figure of 3.4%, cited by Caylor,[4] seems to be the most reasonable and widely accepted.

The frequency of malignant change in sebaceous cysts is difficult to determine, for at least two reasons. There is as yet no universally accepted criterion of identification of sebaceous cysts, particularly of malignant ones. Virchow [16] considered all epithelial-lined cysts of the skin containing semisolid or fluid contents to have origin in sebaceous glands. Broders and Wilson [3] reserved the name "sebaceous cyst" for those in which is found white, granular sebaceous material with an offensive odor, whereas they designated the solid, firm tumors with a lamellated structure as "keratoma." They believed that the keratoma arises from the lining cells of the duct and not from the gland proper. A malignant sebaceous cyst becomes an infrequent lesion indeed when the criterion of Warvi and Gates is applied. Warvi and Gates [17] defined the sebaceous cyst as a retention cyst of sebaceous glands in which the secreting sebaceous gland cells must form an integral part of the lining.

Until some standard of identification is adopted, the true incidence of malignant change in sebaceous cysts will remain conjectural. It wil be at least difficult to arrive at an accurate incidence until all published figures include only those studies in which all specimens removed are subjected to pathologic analysis. In four of the larger case studies reviewed, both Bishop [2] and Peden [12] examined microscopically all excised lesions, whereas neither Caylor [4] nor Stone and Abbey [14] studied microscopically all cysts removed surgically.

The incidence of malignant degeneration of sebaceous cysts thus far reported in the literature, and it is certainly true of this study, is no greater than one would expect considering the age incidence and other causative factors. The sebaceous cyst should not be considered as a precancerous lesion. This is in agreement with Love and Montgomery,[10] who emphasize that they are not to be so regarded, if indeed any lesions should be, as Hellwig [7] questions.

Present Study

Methods and Materials.—At this clinic Hertzler [9] noted only three malignant sebaceous cysts in over 30 years of observation. In the last three years at the Hertzler Clinic 239 cysts have been examined, and of this number 128 proved to be benign sebaceous cysts, whereas 6 were carcinomas with definite origin in sebaceous cysts. The remaining 106 were varieties of epidermoid cysts, of which 3 were malignant. The incidence of malignancy arising in sebaceous

Submitted for publication July 2, 1957.

From the Department of Surgery, the Hertzler Clinic, and the Hertzler Research Foundation.

Fig. 1.—Sebaceous cyst with epithelial lining which does not show the differentiation of epidermoid cysts or normal epithelium (at right).

cysts in our series is 4.7%, according to the stricter criterion, or 3.7%, using the broader interpretation of sebaceous cysts.

The criteria for identification of sebaceous cysts and the histological method of distinguishing between them and epidermoid cysts employed at the Hertzler Clinic by Hellwig,[8] pathologist, are in essential agreement with Love and Montgomery.[10] If the wall of the cyst shows keratinization and if the presence of a stratum granulosum can be demonstrated histologically, the cyst is an epidermoid cyst. The sebaceous cyst is filled with sebaceous cells and debris and frequently contains large amounts of cholesterol and crystals. The wall of the cyst is smooth, and definite sebaceous cells are identified in the wall. The cyst wall is usually only a few layers thick, and there is little or no attempt at keratinization (Fig. 1). The typical histological picture of malignant degeneration of a sebaceous cyst is demonstrated in Figures 2 and 3.

Age and Sex.—This series is hardly large enough to warrant inclusion of statistics on sex, age, site, and duration were it not for some unusual findings thereby revealed. The average age of our patients

Fig. 2.—Basal-cell carcinoma in sebaceous cyst.

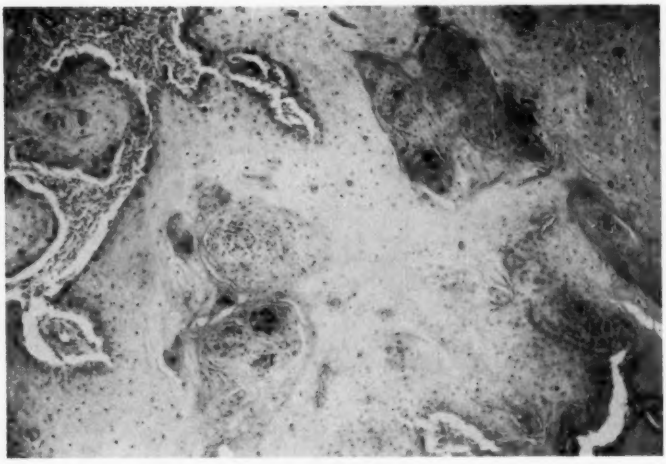


Fig. 3.—Squamous-cell carcinoma in sebaceous cyst.

was 64, which is slightly higher than the reported average but is in accord with that recorded by Bishop,[2] who, in addition, noted that the average age for benign cysts in his material was 38.3 years. This is in essential agreement with our findings and raises the question of greater tendency to malignant change with advancing age. The incidence of males to females was 2:1.

An unusual finding manifest in this investigation concerned the presence of multiple carcinomas. Multiple cysts are quite common, and cases of carcinoma in patients with multiple cysts have been reported; but the simultaneous occurrence of two malignant sebaceous cysts in one patient is unique, no cases having been recorded in the literature. The report of such a case is included.

Site and Duration.—This report is somewhat atypical, again, in that four out of six malignant sebaceous cysts occurred below the neck line—three on the thigh and one on the chest wall. The usual site of predilection is above the shoulder, and especially on the scalp, face, ear, and neck, as reported by both Caylor [4] and Bishop.[2]

The duration of these lesions and the onset of malignancy are difficult to determine. Most patients cannot fix accurately the time of onset within three years. The duration of the lesions in this investigation varied from 2 to 15 years, the average duration being 7 years.

Data on Nine Cases of Carcinoma Arising in Sebaceous Cyst

Case	Age	Sex	Site	Duration	Pathology	Comment
1	45	M	Buttock	3 yr.	Squamous-cell carcinoma arising in sebaceous cyst	Tumor completely removed; no evidence of recurrence or metastasis; well after 9 mo.
2	50	F	Chest wall	2 yr.	Basal-cell carcinoma arising in sebaceous cyst	No evidence of recurrence or metastasis; alive and apparently well after 3 yr.; tumor completely removed
3	74	M	Right leg	10-15 yr.	Basosquamous-cell epithelioma arising in sebaceous cyst	Both sites healed with no evidence of recurrence; well after 2 yr.
4	74	M	Left leg	10-15 yr.	Basosquamous-cell epithelioma arising in sebaceous cyst	
5	77	M	Ear	6 yr.	Squamous-cell carcinoma arising in sebaceous cyst	No follow-up
6	67	F	Scalp	6 mo.	Squamous-cell carcinoma arising in sebaceous cyst	Well, 3 mo. later
7	53	M	Cheek	4 yr.	Epidermoid cyst with lipogranuloma and early basosquamous-cell carcinoma	No follow-up except for 2 mo. postoperatively
8	65	M	Neck	9 mo.	Epidermoid cyst with early squamous-cell carcinoma	No recurrence; no metastasis after 3 yr.
9	38	F	Arm	2 yr.	Epidermoid cyst with squamous-cell carcinoma	Alive and well 1 ½ yr. p. o.

Comment

The indication for surgery in the great majority of our cases of sebaceous cysts was cosmetic. In a few cases the impetus for removal was functional, as in Case 1, in which a telephone line man found that his tool belt rode uncomfortably on the sebaceous cyst on his thigh. But in only a few cases was the most important indication for excision, recent change in size or character, the presenting complaint.

In all cases of malignancy here presented the preoperative diagnosis was benign sebaceous cyst. In the entire investigation only a few lesions were correctly diagnosed preoperatively as epidermoid cyst, the usual diagnosis being benign sebaceous cyst.

The structure of these carcinomatous cysts does not vary greatly. The cyst cavity commonly contains a hornified material, while the cyst wall is composed of well-differentiated cells with strands of squamous cells invading the stroma. There is, as a rule, considerable tendency toward hornification, pearl formation, and intracellular spines. The basal-cell carcinoma and the basosquamous-cell carcinoma exhibit marked proliferation of basal cells, which invade the stroma or the cyst wall. For the most part, the malignancy is of low grade (Broder's classification) with predominance of the adult-type cell structure. In the less well-differentiated tumor, as in one of the cases reported by Seff and Barkowitz,[13] the malignancy grade is high and the prognosis correspondingly poor. The prognosis as a rule is excellent after complete excision.

The treatment for this lesion is early complete excision, to include a generous margin on all sides of the tumor. This is particularly urgent if there has been any recent trauma or change in size or character. Surgery becomes imperative if there has been any history of previous malignancy in addition to trauma or change in size or character. The occurrence of one or more additional primary neoplasms in a patient already afflicted with one such lesion is six or seven times as likely as the first occurrence of a malignancy in an unafflicted patient.[6,18]

The value of roentgen therapy is difficult to appraise, since these tumors are not submitted to biopsy but are removed. According to Ackerman and del Regato,[1] epidermoid carcinomas show different radiosensitivities but are radiocurable. They recommend radical surgery and the withholding of x-ray therapy until the presence of recurrence or metastasis is demonstrable.

Report of a Case

A retired farmer, aged 74, was admitted to the Halstead Hospital on Jan. 16, 1955, for a right inguinal herniorrhaphy, which was duly performed. During an uneventful convalescence, the patient requested that a cystic tumor of his left leg be removed, and this was done on the third postoperative day. When the pathologic report was returned as basosquamous-cell carcinoma arising in the sebaceous cyst, the patient requested that two additional sebaceous cysts be removed, one on the right hip and one on the chest wall. On Jan. 24, these two lesions were removed surgically, and the pathologic report on the one on the right hip was basosquamous-cell carcinoma arising in a sebaceous cyst. The wounds healed without incident, and the patient has been seen at three-month intervals since, without evidence of recurrence or metastasis. He is reasonably well for his age, with no evidence of malignancy.

The Follow-Up Study

Since all these patients were relatively recently afflicted, the follow-up is necessarily of short duration, the longest being three years and the shortest three months. All these patients, except one, have been carefully followed, and all are alive and reasonably well, with no evidence of recurrence or metastasis. Since these cases were all of early carcinomatous degeneration, Broders' Grade 1 or Grade 2, and were completely removed, no recurrences, metastases, or deaths from the disease are anticipated, but the follow-up observations will continue.

Collins,[5] summarizing all published cases, noted that of five cases of epidermoid

carcinoma, Grade 3 or Grade 4, according to Broders' classification, 40% died of recurrences, while in cases of Grade 1 or Grade 2 no deaths were attributable to recurrence of the carcinoma. The prognosis seems excellent with complete surgical removal except in those cases with Grade 3 or Grade 4 lesions, in which the prognosis must be guarded.

Summary

A series of cutaneous cysts, 239 in number, surgically removed and microscopically examined at the Hertzler Clinic, is presented. These cysts were differentiated as epidermoid cysts, benign and malignant, and sebaceous cysts, benign and malignant. The incidence of malignant degeneration of sebaceous cysts is 4.7%. At least one singular finding, that of simultaneous multiple sebaceous cyst malignancies, evolved from the study, and the case history is presented. A review of the literature revealed no histological standard differentiation of sebaceous cyst and epidermoid cyst, and only a few records in which the true incidence of malignancy could be judged. The statistics, including age (average, 64 years), sex (males, 2:1), site, and duration (seven years) are reported, and the treatment, follow-up, and prognosis are discussed.

Conclusions

1. All sebaceous cysts surgically removed for whatever reason should be subjected to microscopic analysis.

2. Sebaceous cysts should be distinguished from epidermoid cysts, with which at present they are confused.

3. The sebaceous cyst should not be considered or treated as a precancerous lesion, but in all older patients with long-standing cysts with a history of recent change or with a history of previous affliction with cancer, the cyst should be promptly and widely excised.

The Hertzler Clinic.

REFERENCES

1. Ackerman, L. V., and del Regato, J. A.: Cancer: Diagnosis, Treatment, and Prognosis, Ed. 2, St. Louis, The C. V. Mosby Company, 1954, p. 179.

2. Bishop, E. L.: Epidermoid Carcinoma in Sebaceous Cysts, Ann. Surg. 93:109, 1931.

3. Broders, A. C., and Wilson, E.: Keratoma: A Lesion Often Mistaken for Sebaceous Cysts, S. Clin. North America 10:127, 1930.

4. Caylor, H. D.: Epitheliomas in Sebaceous Cysts, Ann. Surg. 82:164, 1925.

5. Collins, D. C.: Carcinoma Originating in Sebaceous Cysts, Canad. M. A. J. 35:370, 1936.

6. Ettinger, J.; Massell, T. B., and Wilkins, F. B.: Six Primary Carcinomas in One Patient, Am. J. Surg. 78:894, 1949.

7. Hellwig, C. A.: The Scientific Basis of Biopsy in Tumors, Arch. Path. 14:517, 1932.

8. Hellwig, C. A.: Personal communication to the author.

9. Hertzler, A. E.: Surgical Pathology of the Skin, Fascia, Muscles, Tendons, Blood and Lymph Vessels, Ed. 1, Philadelphia, J. B. Lippincott Company, 1931.

10. Love, W. R., and Montgomery, H.: Epithelial Cysts, Arch. Dermat. & Syph. 47:185, 1935.

11. Ormsby, O. S.: A Practical Treatise on Diseases of the Skin, Ed. 2, Philadelphia, Lea & Febiger, 1921, pp. 1013-1014.

12. Peden, J. C., Jr.: Carcinoma Developing in Sebaceous Cysts, Ann. Surg. 128:1136, 1948.

13. Seff, I., and Barkowitz, J.: Carcinomatous Degeneration of Sebaceous Cysts, Surg. Gynec. & Obst. 23:469, 1916.

14. Stone, M. J., and Abbey, E. A.: Sebaceous Cyst: Its Importance as a Precancerous Lesion, Arch. Dermat. & Syph. 31:512, 1935.

15. Ricker, S., and Schwalb, J.: Die Geschwülste der Hautdrüsen, Berlin, S. Karger, 1914.

16. Virchow, R., cited by Ormsby.[11]

17. Warvi, W. N., and Gates, O.: Epithelial Cysts and Cystic Tumors of the Skin, Am. J. Path. 19:765, 1943.

18. Welch, J. W.: Multiple Primary Malignant Lesions, J. Kansas M. Soc. 55:314, 1954.

Traumatic Laceration of the Coronary Arteries

J. P. WOODHALL, M.D., Macon, Ga.

Injury to the heart as a result of a stab or gunshot wound is not an uncommon emergency. There exists an apparent increase in the frequency with which these wounds are seen. It is not believed that this increase is due to any surge in the combative nature of the populace; rather, it may result from a better recognition of these wounds by the medical profession.

As early as 1886 Fischer [1] collected 452 cases of cardiac wounds treated by conservative methods. By 1932 Ramsdell [2] was able to find reports of 428 cases of heart wounds which had been operated upon. Bigger,[3] in 1939, reported a collected series of 141 additional heart wounds. Since then there have been numerous reports concerning the proper treatment of these wounds. A controversy arose as to whether cardiac injuries should be treated definitively by operation or whether, when cardiac tamponade was present, pericardial aspiration and supportive therapy were the proper method of treatment. Blalock and Ravitch,[4] though not the first to use pericardiocentesis successfully as a method of treatment of heart injury with tamponade, were the first to use aspiration and supportive therapy successfully in a series of cases. The impact of their paper was tremendous. It was apparent, however, that there would be exceptions of immediate importance to this method of therapy which would require operative treatment: first, continued bleeding, as shown by the recurrence of the cardiac tamponade; second, failure to relieve the cardiac tamponade, due to clotting of the blood; third, associated thoracic or intra-abdominal injuries, necessitating exploration, and, fourth, specific types of cardiac injury, such as severance of a coronary artery. My colleagues and I have been interested in the potentialities of disaster inherent in treating coronary artery severance by aspiration of the concomitant cardiac tamponade. We have had two coronary artery injuries due to stab wounds which illustrate this problem.

Submitted for publication July 2, 1957.

Report of a Case

A 56-year-old Negro was admitted to the emergency room on Dec. 18, 1954, with a stab wound 3 cm. to the left of the sternum in the fourth interspace. The blood pressure was 0/0. No heart sounds were audible, but the patient was conscious, profane, and inebriated. A chest film showed a pear-shaped heart. He was given 1000 cc. of matched and typed blood intravenously. A pericardial tap was performed shortly after arrival at the emergency room; 50-60 cc. of blood was removed. The blood pressure then rose to 80/60. A second tap was performed, but the removed blood rapidly clotted.

The patient was transferred to the ward in fair condition. Recovery was rapid, and he was discharged to his home on his fifth hospital day.

The patient was next seen dead by the medical examiner. At 4 p. m. on Dec. 29 he was seen to fall dead as he walked out of his brother's house. He had not worked since discharge from the hospital.

The following is an excerpt from the report of the medical examiner (Dr. Leonard Campbell):

"Internal Examination.—The stab wound entered the thorax between the fourth and the fifth rib approximately 9 cm. to the left of the midline. It passed through the upper lobe of the left lung and into the pericardium. The entry into the pericardium measures approximately 1 cm. in length, corresponding closely to the measurement on the skin. The pericardial cavity contains a large amount of blood. Some of this blood is old and dark-brown and is distinctly separated from a large amount of recent red clotted blood. The path of the stab wound extended through the pericardium and entered the anterior lateral surface of the heart, striking the wall of the left ventricle. It penetrated one branch of the anterior descending vessel of the left coronary artery. At this point it measures approximately 5 mm. in length. Just beneath the surface is a cystic space

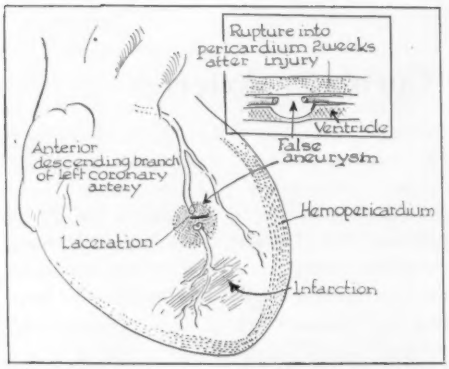


Fig. 1.—Coronary vessel injury in Case 1.

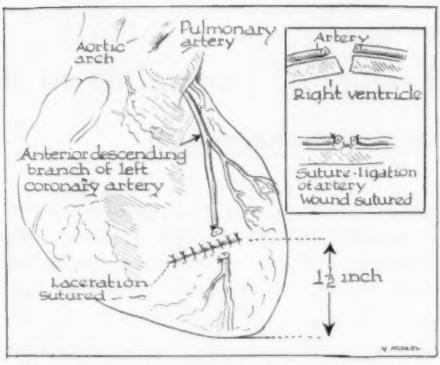


Fig. 2.—Coronary vessel injury in Case 2.

5 mm. in diameter, which appears to have been a temporary aneurysm. Approximately 300 cc. of recently clotted blood exists in the pericardium, and approximately 150 cc. of old blood is present in the pericardium.

"*Heart.*—The wound described on the anterior left lateral aspect of the heart does not enter the ventricular cavity. It passes approximately half way through the thickness of the heart, and the injury is primarily due to the fact that the branch of the coronary vessel was injured. The myocardium peripheral to the site of injury to the vessel is infarcted and shows a mottled purplish-yellow and gray cut section. This infarct measures approximately 1 by 3 cm. and extends to the apex. The heart weighs 430 gm. Other than the injury and the infarct mentioned above, it shows no evidence of disease or injury. The endocardium is smooth. The valve rings and leaflets are normal. The pulmonary artery was opened in situ and contained only fluid blood and postmortem clot."

A 56-year-old Negro man sustained a nonpenetrating stab wound of the left ventricle which severed a branch of the anterior descending branch of the coronary artery. Pericardial tamponade was relieved by aspiration and followed by apparent recovery. Eleven days following injury sudden death occurred, due to recurrent cardiac tamponade when a false aneurysm ruptured at the site of the coronary-artery transection.

This injury was not recognized clinically, since no electrocardiogram was made. Operative intervention would have led to ligation of the coronary vessel with possible recovery, in that the late rupture of the false aneurysm would not have occurred.

A Negro youth, age 17, was admitted to the Charity Hospital of Louisiana, New Orleans, on Oct. 7, 1949 with a stab wound of the left chest received during a fight.

The patient was in severe state of shock, with a sucking wound of the left chest next to the sternum in the fifth interspace. A pressure dressing was applied, and 1500 cc. of blood was withdrawn from the pleural cavity by thoracentesis. With concomitant transfusions the patient's condition stabilized readily. Heart sounds were normal. No pericardial tap was performed. The emergency room diagnosis was severance of the left internal mammary artery.

In surgery the chest was opened through the fifth left interspace. The internal mammary artery had been severed and was ligated. A short rent in the pericardium was noted. No tamponade was present. The traumatic pericardial incision was enlarged. The anterior descending branch of the left coronary artery had been severed (Fig. 2). Both cut ends were oozing blood. Suture ligation of each was performed. The traumatic incision had extended over the surface of the right ventricle. While this was being examined, the wound opened, revealing that the laceration had extended into the right ventricle. This wound was promptly sutured.

Early recovery was uneventful. Serial electrocardiograms were done. On Oct. 17 the first ECG changes indicative of myocardial ischemia appeared. On Oct. 20 these changes were more definite, with left axis deviation, prominent U-waves, TV_2, $_3$, $_4$, $_5$ inverted, TV_6 low, and the Q-T interval slightly prolonged. With succeeding electrocardiographic readings the interpretation of anterolateral myocardial ischemia was fixed. On Nov. 28 the first normal reading was obtained. The last ECG, taken on Oct. 24, a year after injury, was recorded as within normal limits.

A 17-year-old Negro youth received a stab wound of the heart which lacerated a branch of the left coronary artery and pene-

trated the right ventricle. Brisk bleeding occurred into the left hemithorax from the severed internal mammary artery. The heart injury was not diagnosed until exploratory thoracotomy was performed. Ligation of the severed internal mammary artery and the coronary artery and suture of the right ventricle were followed by recovery, despite the myocardial infarction resulting from the coronary injury.

No cardiac tamponade occurred, first, because the rent in the pericardium was sufficiently open to allow blood to escape, and, second, because the right ventricular wound became sealed early, and, indeed, was discovered only when pressure was applied to one side of the fine line, indicating a possible laceration of the heart. When this pressure was applied, the ventricular wound opened. It is difficult to believe that this type of injury would have responded to conservative management, and yet if the internal mammary had not been severed, no exploration would have been performed.

Comment

Blau [5] noted that Cappelen, in 1896, operated upon a heart wound, closing a 2 cm. wound found in the ventricle. A bleeding artery on the heart was tied. The patient lived for two and one-half days, dying of septic pericarditis. It was later in the same year that Rehn first successfully sutured a cardiac wound. Cappelen's case is the first clear record we find of ligation of a coronary vessel associated with a cardiac injury.

The accompanying Table lists the coronary vessel injuries described in the major papers on heart injuries in recent years. Among the 578 cases recorded, only 23 had coronary artery injuries. This appears to be too small a number of coronary artery injuries and may well represent a failure of specificity by the surgeon in describing the heart injuries.

Of these 23 patients with coronary artery injury, 14 survived—12 after operative treatment and 2 after conservative management. Of the nine who died, four were dead on or at admission, three were treated conservatively, and two died during surgery. Under surgical management 12 of the 14 operated upon survived. Under conservative management, two of five patients so treated survived. It is not thought that this material is complete, but these reports suggest that in the past, operative treatment of cardiac injuries with associated coronary artery injury has met with a fair measure of success.

It would be most logical to assume that the conservative management of a coronary artery injury would be the sensible course to follow. The patient so injured not only

Coronary Vessel Injuries Reported Since 1939

Author	Year	No. of Cases	Coronary Vessel Injured	Status	
				Living *	Dead †
Bigger [3]	1939	141	2	2 (S)	0
Elkin [6]	1939	1	1	0	1 (C)
Elkin [7]	1941	38	3	3 (S)	0
Griswold & Maguire [8]	1942	47	2	1 (S)	1 (DOA)
Blalock & Ravitch [4]	1943	4	0	0	0
Elkin [8]	1944	23	No mention		
Blau [5]	1945	21	No mention		
Maguire & Griswold [10]	1947	33	0	0	0
Ravitch & Blalock [11]	1949	17	1	0	1 (C)
Elkin & Campbell [12]	1951	18	2	2 (C)	0
Menendez [13]	1952	4	0	0	0
Maynard, Cordice, & Naclerio [14]	1952	81	7	5 (S)	2 (S)
Griswold & Drye	1954	38	No mention		
Cooley, Dunn, Brockman, & DeBakey [16]	1955	57	No mention		
Maynard, Avecilla, & Naclerio [17]	1956	43	3	0	3 (DOA)
This report	1957	2	2	1 (S)	1 (C)
Totals		576	23	12 (S)	4 (DOA)
				2 (C)	3 (C)
				14	2 (S)
					9

* S indicates surgical treatment.
† C indicates conservative treatment; DOA, dead on arrival—autopsy record.

suffers from the initial shock, blood loss, associated injuries, and tamponade but must withstand a myocardial infarction as well. Such a patient should not be put through the stress and trauma of a major surgical procedure; however, coronary artery injury presents the possibilities of (1) continued bleeding, either into the thoracic cavities or within the pericardium, producing tamponade and recurrent tamponade, and (2) the potential formation of a false aneurysm. For these two reasons, coronary artery injuries deserve particular thought and caution when a surgeon determines the course of therapy he intends to follow.

Of the coronary artery injuries recorded here, five were treated conservatively. Elkin [13] reported the two successfully treated patients, each of whom showed myocardial infarction by electrocardiographic study. Two of the patients who died under conservative management died of rupture of a false aneurysm which had formed at the site of severance of the coronary vessel. The case reported by Elkin [6] in 1939 is almost identical with Case 1 reported here. Ligation of the divided vessel in each instance would have prevented the formation of a false aneurysm; and since death in each case resulted from the rupture of the aneurysm, operative treatment would have been a wiser course to follow. Ravitch and Blalock [11] reported the other case of coronary injury, stating that aspiration was successful in that it relieved the tamponade but that cardiac failure as a result of the infarction and fluid administration produced death. The autopsy report in Ravitch and Blalock's case states that "the missile had transected the first branch of the anterior descending branch of the left coronary artery and produced a large hematoma in the myocardium and epicardium which appeared to have compressed the anterior descending branch of the left coronary artery." This description of the pathology in their case suggests that if the patient had survived, a false aneurysm could well have resulted at the site of coronary artery injury. Thus in two of the five cases available for analysis death occurred from rupture of a false aneurysm at the site of the coronary artery injury and in a third autopsy clearly demonstrated the pathological situation from which a false aneurysm could arise.

In Case 2 recorded here exploration was done because of severance of the left mammary artery. There was no tamponade. The laceration in the pericardium was noticed during surgery, and exploration demonstrated the coronary artery injury and the wound which extended into the right ventricle. Ligation of the cut ends of the coronary artery and suture of the ventricular wound resulted in recovery. It was this type of case which Matas [18] referred to in 1909—in which, without treatment, secondary hemorrhage could occur from the wound or in which the epicardium might heal with a thin scar, the remainder of the wound being in communication with the ventricular cavity. It was suggested that this type of healing might lead to cardiac aneurysms and potential future blow-outs. Griswold and Drye [15] referred to this in their recent paper. It is also this type of wound which Ravitch suggests does not require suture, stating that the initial pressure produced by the cardiac tamponade controls bleeding and that relief of the tamponade with proper supportive treatment constitutes the correct procedure for most heart wounds. The wound in Case 2 reported here had closed without the benefit of the pressure of tamponade.

The results of the conservative management of heart wounds obtained by Ravitch and Blalock,[11] Elkin and Campbell,[13] and Menendez,[12] among others, are most impressive. The initial results obtained by these authors are considerably better than those obtained by operative management, but the number of recorded cases is as yet rather small. Elkin, who for many years advocated operative therapy, in 1951 published a report of 18 cases of cardiac injury, in 17 of which treatment was by

pericardiocentesis and supportive measures, with only 1 death. This remarkable series is noteworthy also in that no associated injuries requiring surgery occurred among these 17 cases. Few emergency surgeons have such good fortune or, on the other hand, possess such good judgment. It should be emphasized that he who elects to treat heart wounds conservatively should be prepared to intervene surgically at any moment. The dramatic physiological improvement produced so rapidly by pericardiocentesis should never obscure the seriousness of the situation.

It has been the purpose of this paper to demonstrate that coronary artery injury adds a feature to heart wounds which requires definitive surgical management for control. In the cases available for study operative therapy was reasonably successful in that 12 or 14 patients operated upon lived. Of the five treated conservatively, two lived, two developed false aneurysms, which ruptured and produced death, and one, after early response to pericardiocentesis, died, autopsy demonstrating the type of pathology that would be expected to precede aneurysm formation. The cases available for study demonstrate that a severed coronary artery requires ligation rather than expectant therapy. It is by surgical management that the late complications of coronary artery injury—continued bleeding or false aneurysm formation—can best be avoided.

Summary

Two cases of coronary artery injury are reported. The major reports in the literature of heart wounds were surveyed for coronary artery injury. An analysis of the 23 cases available for study showed that surgical management was reasonably successful and that false-aneurysm formation at the site of coronary artery injury is a real hazard of the conservative management of such wounds.

724 Hemlock St.

REFERENCES

1. Fischer, G.: Arch. klin. Chir. 9; 608, 1886; cited by Cooley et al.[16]

2. Ramsdell, E. G.: Stab Wounds of the Heart, Ann Surg. 99:141 (Jan.) 1934.

3. Bigger, I. A.: Heart Wounds: Report of 17 Patients Operated upon in Medical College of Virginia Hospitals, with Discussion of Treatment and Prognosis, J. Thoracic Surg. 8:239 (Feb.) 1939.

4. Blalock, A., and Ravitch, M. M.: A Consideration of the Nonoperative Treatment of Cardiac Tamponade Resulting from Wounds of the Heart, Surgery 14:157 (Aug.) 1943.

5. Blau, M. H.: Wounds of the Heart, Am. J. M. Sc. 210:252 (Aug.) 1945.

6. Elkin, D. C., in discussion on Bigger.[3]

7. Elkin, D. C.: Diagnosis and Treatment of Cardiac Trauma, Ann. Surg. 114:169 (Aug.) 1941.

8. Griswold, R. E., and Maguire, C. H.: Penetrating Wounds of the Heart and Pericardium, Surg. Gynec. & Obst. 74:406 (Feb.; No. 2A) 1942.

9. Elkin, D. C.: Wounds of the Heart, Ann. Surg. 120:817 (Dec.) 1944.

10. Maguire, C. H., and Griswold, R. A.: Further Observations on Penetrating Wounds of the Heart and Pericardium, Am. J. Surg. 74:721 (Nov.) 1947.

11. Ravitch, M. M., and Blalock, A.: Aspiration of Blood from Pericardium in Treatment of Acute Cardiac Tamponade After Injury, Arch. Surg. 58:463 (April) 1949.

12. Menendez, C. V.: Stab Wounds of the Heart and Pericardium Producing Acute Cardiac Tamponade, Treated by Aspiration of Pericardium, Am. Surgeon 18:66 (Jan.) 1952.

13. Elkin, D. C., and Campbell, R. E.: Cardiac Tamponade: Treatment by Aspiration, Ann. Surg. 133:623 (May) 1951.

14. Maynard, A. de L., Cordice, J. W. V., Jr., and Naclerio, E. A.: Penetrating Wounds of the Heart: Report of 81 Cases, Surg. Gynec. & Obst. 94:605 (May) 1952.

15. Griswold, R. A., and Drye, J. C.: Cardiac Wounds, Ann. Surg. 139:783 (June) 1954.

16. Cooley, D. A.; Dunn, J. R.; Brockman, H. L., and DeBakey, M. E.: Treatment of Penetrating Wounds of the Heart, Experimental and Clinical Observations, Surgery 37:882 (June) 1955.

17. Maynard, A. de L.; Avecilla, M. J., and Naclerio, E. A.: Management of Wounds of the Heart: A Recent Series of 43 Cases with Comment on Pericardicentesis in Nemopericardium, Ann. Surg. 144:1018 (Dec.) 1956.

18. Matas, R., in Keen, W. W.: Surgery, Its Principles and Practice, Philadelphia, W. B. Saunders Company, 1909, Vol. 5, p. 17.

Injuries of the Trachea

A. RICHARD GRAY, M.D.; JOHN M. HOWARD, M.D.; WILLIAM H. HARRISON Jr., M.D., and CECIL M. COUVES, M.D., Atlanta

A review of the patients with traumatic injuries admitted to Grady Memorial Hospital since 1948 includes nine patients with injuries of the trachea, each of whom received his total treatment at this hospital. Since the literature contains only two comparable civilian records,[5,15] this experience has been summarized.

The patients were all young or middle-aged adults. Eight were injured in fights, the ninth patient being injured in an automobile accident. None of the injuries was self-inflicted. Two were injured by blunt trauma, two by bullets, and five by knives (Table 1). The injuries in the last group were of two types: stab wounds and horizontal lacerations.

Submitted for publication June 4, 1957.

This study was supported in part by Department of the Army Grant DA-49-007-MD-732.

Clinical Findings

The clinical features, specific for tracheal injuries, were determined by the type of wound. The lacerations, as a group, lacked the rather distinguishing characteristics. In the laceration, respiration was associated with the free ingress and egress of air through the wound, not unlike that of an operative tracheotomy except for the associated bleeding, which occurred both externally and into the trachea. Under such

Injuries of the Trachea

Case No.	Nature of Injury	Clinical Findings	Treatment	Result
1	Kicked—stellate rupture	Massive subcutaneous emphysema, which, under observation, rapidly spread from supraorbital area to midthighs; dyspnea; hemopneumothorax	A 1.5 cm. stellate rupture found; tracheotomy tube inserted through wound	Died 3d day of hemothorax syphilitic aortitis
2	Automobile accident—rupture of trachea at carina	Crush injury with fractured sternum and ribs; delayed onset of pneumothorax; subcutaneous emphysema over neck and chest; dyspnea, cyanosis, paradoxical respiration	Immediate tracheotomy and stabilization (by suspended weights) of sternum; delayed institution of closed drainage of pleural cavity	Improved 48 hr., after which he developed restlessness, cyanosis, shock, stupor, and temperature of 104 F; died 3d day after injury; autopsy revealed tracheal rupture at carina with penetration into anterior mediastinum
3	Bullet—perforation	Mild respiratory difficulty; marked, rapidly developing subcutaneous emphysema	Tracheal wounds sutured; tracheotomy performed lower in neck	Cured
4	Bullet—perforation	Subcutaneous and mediastinal emphysema	Tracheotomy after repair of perforation	Cured
5	Knife—stabs of neck and chest	Pneumothorax, hemothorax, shock; moderate subcutaneous emphysema; febrile course; on 5th day, tracheocutaneous fistula developed	Closed pleural drainage; on 5th day cervical wound explored and tracheotomy performed at point of laceration	Cured (hospitalized 41 days)
6	Butcher knife—lacerations of neck and chest	Hemorrhage from wound and hemoptysis; hemopneumothorax	Immediate tracheotomy, followed by repair of severed trachea and lacerated esophagus; closed drainage of pleural cavity	Cured
7	Knife—stab	Moderate respiratory distress; minimal leakage of air	Antibiotics and observation	Cured
8	Knife—laceration	Laceration without respiratory manifestations	Tracheotomy tube inserted through laceration	Cured
9	Knife—stabs of neck and chest	Hemopneumothorax with atelectasis; subcutaneous emphysema in neck only, and this not prominent on admission; hemoptysis once; wounds sutured; 12 hr. later (4:30 a.m.) dyspnea developed and both supraclavicular areas "began to balloon with each breath"; choking sensation and substernal pain followed	Cervical sutures removed and tracheotomy tube inserted through laceration (12 hr. after admission); closed drainage of pleural cavity	Cured

circumstances, the diagnosis was not difficult. By contradistinction, blunt trauma or stab wounds produced tracheal fracture or puncture with an intact skin or only a small cutaneous incision, respectively. In the latter instance, the skin and subcutaneous tissues sometimes shifted so as to occlude the wound tract. In either instance, air was usually forced from the trachea into the subcutaneous tissues, and sometimes into the mediastinum. Respiratory distress resulted or, at least, coincided. These two features, subcutaneous emphysema and respiratory distress, were the two manifestations of closed, stab, or puncture wound of the trachea.

Diagnosis was made difficult by two factors: First, the leakage of air from the trachea occasionally had a delayed onset, and, second, associated thoracic injuries were frequent, and both the subcutaneous emphysema and the respiratory distress were erroneously attributed to the latter type of injury.

The subcutaneous emphysema which resulted from tracheal injuries had three characteristics. It began in the neck, sometimes spread with amazing rapidity, and occasionally extended to massive proportions. Most of the time it had spread beyond the neck by the time of hospital admission. In one patient, who first developed the subcutaneous emphysema in the hospital, the nurse described both supraclavicular areas as suddenly "ballooning out." The changes appeared not unlike those seen at a thoracotomy when the anesthesiologist expands the collapsed lung. Subcutaneous emphysema was not always massive in extent, but on one occasion it extended from the swollen periorbital tissues to the midthighs. Mediastinal emphysema was clinically evident in only three patients.

Various degrees of respiratory distress were characteristically evident. In two instances immediate tracheotomy seemed lifesaving; in others it appeared unnecessary. In three patients impairment of respiratory function was not evident and the injury appeared to be so slight that emergency treatment was deemed unnecessary at the time of admission. One of these patients who had suffered a stab wound continued an uneventful course on nonspecific therapy. In a second patient the stab wound of the chest was erroneously blamed for the slight subcutaneous emphysema in the lower cervical area and for the single episode of hemoptysis. Twelve hours later, at 4:30 a.m., the patient suddenly developed massive subcutaneous emphysema, substernal pain, and dyspnea and almost suffocated before a tracheotomy was accomplished at the bedside. The third patient had a cervical stab wound which was considered insignificant, but he was hospitalized because of a stab wound in the chest. His course was febrile until the fifth day, when the cervical wound began to bubble small amounts of air. Following tracheotomy, his course improved, although his period of hospitalization totaled 41 days.

The only patient who experienced immediate marked changes in the quality of his voice was the one whose trachea was severed. In five patients pneumothorax and hemothorax, secondary to direct thoracic injury, complicated interpretation of the clinical picture to a major extent.

Treatment

Treatment consisted primarily of restoration of an adequate respiratory exchange, followed by repeated endotracheal aspirations and systemic antibiotics to prevent atelectasis and infections.

One patient did not require tracheotomy; of the remaining group, four had the tracheotomy tube inserted through the knife wound of the trachea or through the site of tracheal fracture. The bullet wounds of the trachea were closed by primary suture, and separate tracheal incisions were made below or immediately above the wound for insertion of the tracheotomy tube. The patient whose trachea was completely divided and whose esophagus was partially severed had a low tracheotomy performed in the emergency room, followed by a formal exploration and repair of the esophagus and trachea.

Four of the five patients with thoracic injuries were treated by intercostal (closed) tube drainage of the pleural cavity.

The two patients with blunt injury died. One was a patient who was injured by being kicked in the neck. The blows produced a stellate fracture (1.5 cm. in diameter) of the lower, anterior tracheal wall. Immediate tracheotomy resulted in improvement, but respiratory distress recurred intermittently thereafter. He developed a hemopneumothorax, the magnitude of the blood loss not being fully recognized. After his death, on the third day, autopsy revealed 2000 ml. of blood in his pleural cavity.

Another patient was injured in an automobile accident, his chest striking the steering wheel. On admission, he was intoxicated, moderately hypotensive, and had both subcutaneous emphysema and respiratory distress. A tracheotomy resulted in improvement in his respiratory exchange. A crushed thoracic cage was partially stabilized by fixation of the fractured sternum by suspended weights. His initial film did not reveal a pneumothorax, but subsequently this complication was detected clinically. Aspiration, followed by closed pleural drainage via an intercostal tube, controlled the pneumothorax.

His course was satisfactory for the first two days. Thereafter he became restless and developed an increasing cyanosis and fever until his death, on the third day. Autopsy revealed an unsuspected rupture of the trachea at the carina. Air was present in the mediastinum. Bleeding into the mediastinum was minimal, but there was marked extrapleural extravasation around the fractured ribs.

The other patients were cured without additional complications. They have now been followed two to seven years and have not developed clinical evidence of stenosis.

Comment

Tracheal injuries are infrequent, the 9 patients in this series having been treated during the time that 959 patients were hospitalized with thoracic injuries. The low incidence is also reflected in the surgical literature. Hamilton Bailey [1] mentioned 57 patients who attempted suicide by cutting their throats. Each of this group had incised his airway, but the surprising feature was that only four had tracheal lacerations; the others had laryngeal lacerations or lacerations above the hyoid bone through the floor of the mouth.

Physiological Observations.—The physiological basis for the clinical picture has been well documented in the clinical observations by Streit.[20] His patient, a man, was struck by a timber across the side of the neck. He was examined by a physician, who, on the basis of negative findings, returned him to work. The patient then strained in lifting a heavy timber and immediately noted a swelling under the angle of his jaw at the site of injury. The swelling rapidly extended, and dyspnea followed. This onset of subcutaneous emphysema with straining is similar to the rapid spread noted by Goldstein [6] in the infants who were presumably crying and uncontrollable. In the latter report there were two tragic instances where hypodermic needles, intended for jugular venipunctures, accidentally penetrated the trachea of 7- and 9-day-old infants, respectively. One died in 40 minutes, the other in 2½ hours, with respiratory impairment and associated subcutaneous and mediastinal emphysema. Before autopsy, in each instance, the clinical impression had been penetration of the lung by the needle.

During quiet respiration, the endotracheal pressure is near atmospheric pressure. During inspiration, the endotracheal pressure drops 2-3 mm. Hg below, and during expiration it increases 2-3 mm. Hg above, atmospheric pressure. With vigorous respiratory efforts with the larynx closed, such as depicted by the lifting action above, the endotracheal pressure may be increased 60-100 mm. Hg above atmospheric pressure.[9] Similarly, during inspiratory efforts in the presence of tracheal obstruction, the descending diaphragm and the expanding rib

cage may result in a drop of 50-60 mm. Hg below atmospheric pressure in the trachea. Following tracheal injury, partial organic or functional obstruction to the egress, as well as to the ingress, of air may result. A varying percentage of each tidal volume of approximately 500 ml. may thus be forced into the subcutaneous tissues. Personal observations made a few minutes after the death of patients indicate that 5 ml. of air injected into the subcutaneous tissues is easily detected clinically as subcutaneous emphysema. The rapid injection of 50 ml. of air beneath the skin of the thorax results in an area of subcutaneous emphysema of 40-45 sq. cm.; 100 ml., of 75-100 sq. cm., and 200 ml., of 100-150 sq. cm. In the cervical area, in the absence of adipose tissue, emphysema is even more prominent. Thus only a small fraction of the tidal volume of one or two expiratory movements may result in subcutaneous emphysema which is clinically prominent. Perhaps the extension of the emphysema into the mediastinum is responsible for the increasing dyspnea and cyanosis. The mechanism is not obvious but would seem to be the result of compression of the venous return rather than compression of the airway.

Nixon [16] described a patient in whom spontaneous rupture of the trachea was followed by subcutaneous emphysema which, within a few minutes, perforated the skin in three places. Establishment by tracheotomy of a free passageway not only assures respiratory integrity but prevents the development of major increments in endotracheal pressure so that the subsequent spread of subcutaneous and mediastinal emphysema is minimized.

Satisfactory healing of tracheal wounds has been experienced clinically following the removal of countless tracheotomy tubes. Experimental confirmation and delineation of the usefulness of autografts and homografts have been described by several investigators.[3,4,13]

Treatment.—As described above, lacerations present no major diagnostic problems. Nach and Rothman [15] reported 11 patients with injuries of the trachea, the majority of the injuries being penetrating (knife wounds) in type. They repaired approximately half of their group without tracheotomy. When tracheotomy was deemed advisable, they usually inserted the tracheotomy tube through the traumatic tracheal incision. Such a simple technique, as in the current experience, proved satisfactory. Each of their patients was managed under local anesthesia except one, who required repair of a transected trachea and esophagus. Only one patient in their series died, death being due to venous hemorrhage.

Fogelman and Stewart,[5] in an analysis of 100 patients with penetrating wounds of the neck, had 10 with tracheal injuries. Five of their patients were injured by knives, five by bullets. Most of their patients were treated by tracheotomy, although two were repaired primarily without tracheotomy. One patient died of associated injuries. On the basis of the over-all experience with the 100 patients, the authors recommended primary exploration of all penetrating wounds of the neck.

Most of the reports of civilian and military experiences on penetrating injuries have been limited chiefly to reports of reconstruction of the trachea following post-traumatic stenosis.[2,10-12]

Many observers have reported isolated instances of rupture or fracture of the trachea by direct, blunt force,[7,8,14,17-22] the early reports having been summarized by Zeuch.[23] Most of the patients have experienced immediate escape of air into the subcutaneous tissues. Dyspnea has been a prominent feature; in fact, respiratory obstruction has been the chief cause of death. Bleeding into the severed trachea has been a secondary cause of respiratory obstruction.[21]

Summary

Nine patients have been treated for tracheal injuries. Difficulties have arisen primarily due to the failure to explore adequately all wounds of the neck. Occa-

sionally, subcutaneous emphysema and respiratory distress have been erroneously attributed to the associated thoracic injuries.

Treatment has consisted essentially of tracheal suture and tracheotomy. Small anterior tracheal wounds appeared, in this limited experience, to be adequately treated by surgical exposure of the defect with insertion of the tracheotomy tube through the preexisting tracheal defect.

Both patients with blunt injuries died as a result of failure to appreciate the total extent of the injury.

Emory University, 69 Butler St., S. E. (3) (Dr. Howard).

REFERENCES

1. Bailey, H., and Matheson, N. M.: Emergency Surgery, Pt. V, Ed. 6, Bristol, England, John Wright & Sons, Ltd., 1953, pp. 653-655.

2. Burton, J. F., and Anderson, H. M.: Injuries of the Larynx and Trachea, South. Surgeon 15: 579-583, 1949.

3. Daniel, R. A., Jr.; Taliaferro, R. M., and Schaffarzick, W. R.: Experimental Studies on the Repair of Wounds and Defects of the Trachea and Bronchi, Dis. Chest 17:426-441, 1950.

4. Davies, O. G., Jr.; Edmiston, J. M., and McCorkle, H. J.: The Repair of Experimental Tracheal Defects with Fresh and Preserved Homologous Tracheal Grafts, J. Thoracic Surg. 23:367-376, 1952.

5. Fogelman, M. J., and Stewart, R. D.: Penetrating Wounds of the Neck, Am. J. Surg. 91:581-596, 1956.

6. Goldstein, P.: Fatal Interstitial and Mediastinal Emphysema Following Accidental Needle Perforations of the Trachea During Jugular Venipuncture, Am. J. Dis. Child. 78:375-383, 1949.

7. Guerinot, A. J.: Traumatic Injuries to the Trachea, Pennsylvania M. J. 33:62-63, 1929.

8. Henry, G. A.: Traumatic Rupture of the Lower Trachea with Stenosis: A Case Report, Ann. Otol. Rhin. & Laryng. 61:1114-1119, 1952.

9. Fulton, J. F., Editor: A Textbook of Physiology, Ed. 17, Philadelphia, W. B. Saunders Company, 1955.

10. Knight, J. S.: Injuries to the Trachea and the Esophagus Incurred in Combat, Ann. Otol. Rhin. & Laryng. 55:656-666, 1946.

11. Lederer, F. L., and Howard, J. C.: Wartime Laryngeal Injuries, Arch. Otolaryng. 43:331-343, 1947.

12. Longmire, W. P., Jr.: The Repair of Large Defects of the Trachea, Ann. Otol. Rhin. & Laryng. 57:875-883, 1948.

13. Maisel, B., and Dingwall, J. A.: Primary Suture of the Divided Cervical Trachea: A Preliminary Experimental Study, Surgery 27:726-729, 1950.

14. Metson, B. F.: Subcutaneous Rupture of the Trachea, A. M. A. Arch. Otolaryng. 57:182-187, 1953.

15. Nach, R. L., and Rothman, M.: Injuries to the Larynx and Trachea, Surg. Gynec. & Obst. 76:614-622, 1943.

16. Nixon, J. W.: Spontaneous Subcutaneous Rupture of the Trachea, J. A. M. A. 85:1221, 1925.

17. Pendergrass, R. C.: Emphysema of the Neck from Rupture of the Trachea, Radiology 26:499-500, 1936.

18. Richards, V., and Cohn, R. B.: Rupture of the Thoracic Trachea and Major Bronchi Following Closed Injury to the Chest, Am. J. Surg. 90: 253-261, 1955.

19. Rieman, A. P., and Goldsmith, A. S.: Subcutaneous Rupture of the Trachea, J. A. M. A. 108:1605-1606, 1937.

20. Streit, A. J.: Massive Emphysema Following Tracheal Injury, Texas J. Med. 28:615-616, 1933.

21. Taylor, J.: A Case of Traumatic Rupture of the Trachea, J. Laryng. & Otol. 49:593, 1934.

22. Thompson, J. J., and Eaton, E. R.: Intrathoracic Rupture of the Trachea and Major Bronchi Due to Crushing Injury, J. Thoracic Surg. 29:260-270, 1955.

23. Zeuch, L. H.: Sub-Cutaneous Rupture of the Trachea, Illinois M. J. 41:451-454, 1922.

Pilonidal Cyst—Neither Pilonidal Nor Cyst

LIEUT. COL. ROBERT M. HARDAWAY (MC), U. S. Army

Pilonidal disease is apparently much commoner in the military service than in civilian life. This is because (*a*) pilonidal sinus is a disease primarily of young men, and (*b*) conditions of military life are conducive to the start of symptoms. A total of 77,637 soldiers [1] were admitted to Army hospitals for pilonidal disease from 1942 to 1945. This is the equivalent of five infantry divisions. These figures do not include 9000 other cases of pilonidal cyst admitted primarily for other disease or hundreds of thousands of outpatient visits.[1]

Prior to World War II the accepted treatment for pilonidal disease in the Army was excision, and this persists in civilian practice today. The Army, however, has come to accept a much more conservative treatment.[2] Although the rate of hospital admissions has increased slightly (3.05 per 1000 *vs.* 3.24 per 1000), the average number of days spent in the hospital by each patient with pilonidal disease declined from an average of 43.6 in World War II to 24.2 in 1953.[1] In this hospital (serving an overseas theater area where troops spend much time in the field) the admission rate for pilonidal disease was 1.03 per 1000 for the past year, and the average patient stay for pilonidal disease was 6.6 days. These data would tend to justify the change in treatment.

What dictated this change? It was the sum of many experiences like my own. I performed 144 excisions of symptomatic pilonidal sinus in 17 months prior to World War II, with primary healing in more than 90%. The results seemed good at the time

Submitted for publication May 2, 1957.

Chief Surgical Service, U. S. Army Hospital, Frankfurt, Germany.

From the Surgical Service, 97th General Hospital, Frankfurt, Germany.

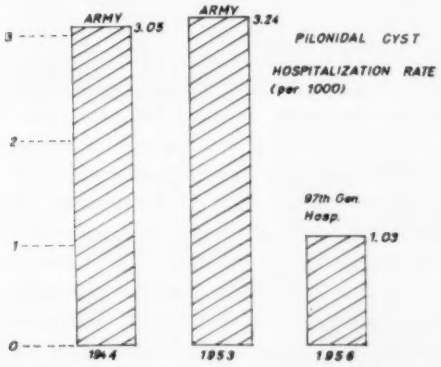


Fig. 1.—Hospitalization rate for pilonidal cyst in the U. S. Army for the years 1944 and 1953, and at the 97th General Hospital in the year 1956. The conservative treatment recommended by the Army after World War II has not affected the hospitalization rate. However, treatment presently used at the 97th General Hospital outpatient clinic has apparently cut hospital admission rate by two-thirds.

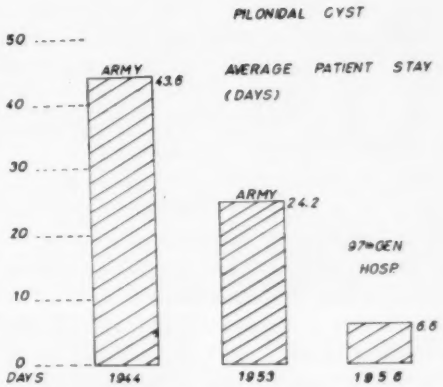


Fig. 2.—Average duration of patient stay in the hospital for pilonidal cyst for the years 1944, 1953, and 1956. The first two columns are Army-wide figures; the third pertains to the 97th General Hospital only. The drop from 43.6 to 24.2 is the result of conservative policy recommended by the Army following World War II. A further reduction at the 97th General Hospital reflects a further decrease in average patient stay as a result of the treatment described in the present article.

and appeared to warrant excision of controlled, but previously symptomatic, pilonidal disease.

However, during subsequent years, follow-up on these patients with "good" results showed that many of them had had recurrent trouble since the first operation. (These patients showed the same small, round midline openings which nonsurgical patients show. Certainly these skin openings were removed at the first operation, which was a wide-block excision. These openings were definitely not congenital.)

Similar results were experienced by the Army as a whole. Although initial results in most properly prepared patients were good, a large proportion had further trouble later. It was not uncommon to see large numbers of patients with pilonidal disease occupying many hospital beds for long periods of time, and performing little or no military duty during their entire Army career. A large proportion gave a history of previous excision, most of which were of the wide-block type. What was wrong? Careful operation seemed completely to excise the "cyst" and its chronically infected, granulation-tissue-lined sinus tracts, but still "recurrences" were common. No method of excision seemed to prevent them, although the types of operation for pilonidal cyst were almost as numerous as the number of surgeons performing them. Attempts to obliterate dead space, preserve normal tissue, cover the sacrum with fat-padded skin, and eliminate buried suture material, and other good surgical principles, seemed to have no dramatic effect. It was said that recurrences were due to inadequate excision of the epithelium of the cyst.[3]

In 1946 the first of a series of papers [4-10] appeared showing that a hair, when introduced into a skin cleft which is constantly in motion (i.e., between the fingers) could erode through the skin and form a sinus tract, which would remain open as a result of the constant foreign-body reaction of the hair. Some of these sinus tracts were lined by squamous epithelium, which simulated a hair follicle. (Hair follicles do not normally occur between the fingers.) The postulation was made that hair in the intergluteal cleft could be sucked into the opening of a "pilonidal cyst" by the constant compression and decompression of riding in a jeep or other vehicle.[9] This brought to mind the fact that, while hair is seen protruding from, or rolled up in, most "pilonidal cysts," it always lifts out easily. The hair is free at both ends. While hair is so frequently present in the tract, hair follicles, numerous in the surrounding skin, are rarely seen in the sinus tract; and when they are seen, the hair is frequently degenerating. None of these "follicles" show accessory glands or a cup-shaped "root" at the bottom. One wonders whether these are real follicles or are small tracts along the hair into which epithelium has grown (Figs. 3 through 5). Infected pilonidal cysts are often seen in hairy persons with deep intergluteal clefts soon after puberty. Pilonidal sinuses may occur in the perineal region, between the toes, and in the axilla.[11-13] All this seems to point to the fact that hairs seen protruding from a "pilonidal cyst" are sticking in and not out. In fact, skin hair may frequently be seen dripping over into the sinus opening. The time (after puberty) of initial infection of the tract and the frequent "recurrence" after adequate excision point to ingrowing hair as a major problem. Given a perfectly normal person with no sinus opening, it is known that poor personal hygiene, sweat, and irritation will produce a painful, tender inflammation with weeping and excoriation in the intergluteal fold. Oriental males seldom have pilonidal disease, and have very little hair in the sacral area. The disease is therefore not congenital, but develops when hair punctures the skin of the internatal cleft and epithelium grows inward along the tract occupied by the hair.[4,14,15] The congenital anal dimple present in many persons is not an embryonic remnant of the neural-tube invagination.[16] Like any other dimple, it is due to the attachment of the skin to underlying bone or fascia by fibrous strands.

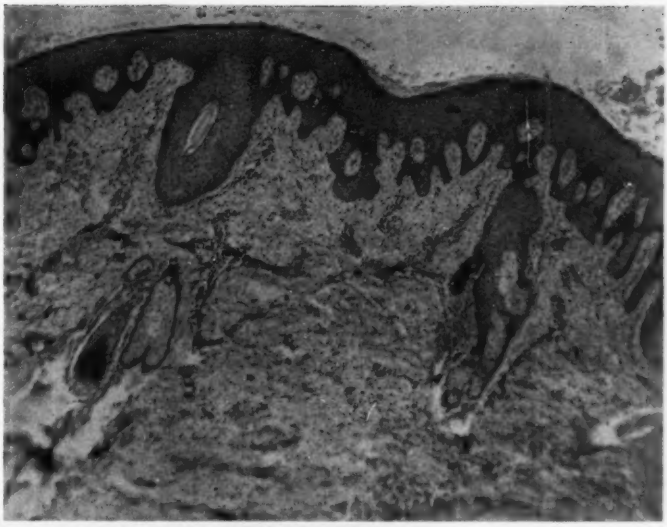


Fig. 3.—Section of skin near the orifice of a pilonidal sinus. Note the close spacing of the hair follicles and the cup-shaped root at the bottom of one of the follicles. The follicles are roughly perpendicular to the skin surface, and sebaceous glands are present. Note that the hair shaft is in good condition.

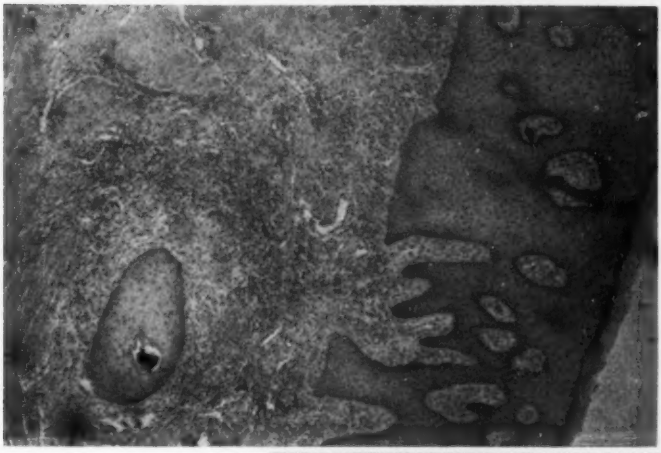


Fig. 4.—Section through a pilonidal sinus. One of the rather rare hair "follicles" is seen. Note that the follicle is not of the usual appearance and appears to run parallel to the epithelium lining the sinus. No cup-shaped root was identified in the sections. Although the epithelium is thriving, the hair in the center is dead and degenerating. No sebaceous glands, normally associated with hair follicles, can be found. This is probably a sinus tract around a foreign-body hair into which squamous epithelium has grown.

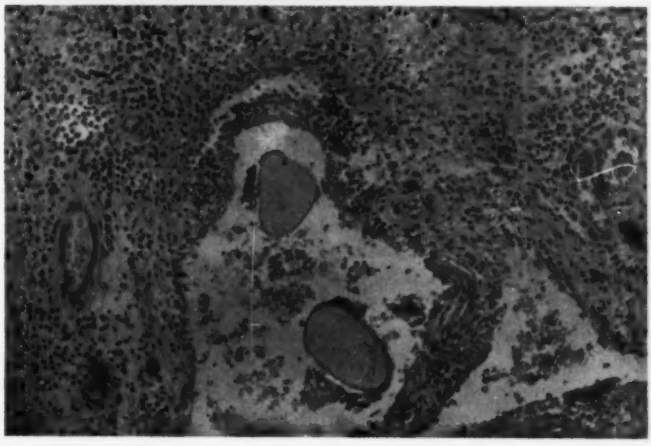


Fig. 5.—Pilonidal sinus with no epithelium. Note hairs in the cavity of the sinus. Epithelium may grow into this sinus around the hair. This tract quickly heals when the hair is removed.

It may form a small superficial pocket, which traps hair and debris in the manner described above.

This theory of origin of pilonidal sinus is shared by the surgical consultant of the British army [17] and by many British Commonwealth surgeons.[4,6-9,11,16,17]

Kleitsch and Cherry [18] explain the "pilonidal sinus habitus" as follows:

1. Young adult: Skin changes due to sex hormones and the development of secondary sex characteristics.

2. Male: Narrow pelvis and deep intergluteal cleft. Less careful personal hygiene. Greater tendency to hairiness. Occupations which produce sacrococcygeal trauma.

3. Hairy: Increased capillarity in internatal cleft, hyperhidrosis.

4. Acne: Increased glandular activity of skin, susceptibility to staphylococcic infections.

5. Obese buttocks: Deepened intergluteal cleft, greater tendency to fecal contamination by capillarity from anus.

As the infection in the depths of the sinus progresses, it crosses and destroys the epithelial barrier and enters the fatty, subcutaneous, episacral tissue. This invokes a fibrous reaction in the fat and produces the so-called pilonidal cyst, which is, in fact, a granuloma at the end of the sinus tract.

Once infection has started, it burrows in much the same fashion as a fistula in ano or hidradenitis suppurativa. In fact, these two conditions are sometimes difficult to differentiate from an infected pilonidal sinus.

With these facts in mind, the following regimen is recommended for managing cases of pilonidal disease in the military service:

1. The entire intergluteal area is shaved (every four to five days) whenever infection is present or threatens, especially in summer, on field problems, etc. All hair is removed from the sinus opening and kept out.

2. Meticulous personal hygiene is observed, with thorough soap-and-water cleansing of the intergluteal area daily. Hexachlorophene detergent should be used if possible. After a bowel movement the anal area is cleaned, with movement away from the intergluteal area, not toward it. The area is kept as dry as possible. Weight reduction is advised in the obese person, and upright sitting with no slouching on the sacrum.

3. A permanent profile is adopted, stipulating that the patient not be assigned as a driver or routine passenger in a vehicle (military police duty, etc.).

4. If there is an abscess, the patient is hospitalized and the abscess drained. If there is a chronic draining sinus unresponsive to the above treatment, the patient is hospitalized and the tract laid open. Hair and debris (occasionally toilet paper), which are nearly always found in the tract, are wiped away. Ordinarily, no tissue is excised, and no sutures are used. Occasionally epithelium at the mouth of the tract is wiped off with a sponge. Healing is rapid. Other patients are not hospitalized. In civilian practice no patient need ordinarily be hospitalized.

5. Excisional surgery is reserved for those few persons (*a*) who have had a failure of an adequate and thorough trial of the above-described treatment, and have required repeated hospitalization, and (*b*) who have a chronic draining sinus. These cases are certainly rare. I have not seen one since our present treatment was adopted, five years ago.

Excision should be done only after drainage and inflammation have been controlled by proper surgical drainage, shaving of the area, and cleanliness. Excision should remove only diseased tissue, as in excision of a fistula in ano. The skin should be tacked down to the sacrum and not sutured primarily.

If excision is decided on, the patient should be informed that his chances of having subsequent trouble are altered little by the operative procedure, and that his best chance of avoiding relapses is by careful adherence to the previously described regimen. As a matter of fact, the most difficult cases to control are in those patients who have had a previous excision.

Summary and Conclusions

"Pilonidal cyst" is neither hair growing nor a cyst, but is an acquired intergluteal sinus secondary to ingrown hair from the

intergluteal skin with added infection and granuloma or abscess. "Recurrence" and infection of "cysts" are usually due to ingrown hair, trauma, and poor personal hygiene. Treatment is best carried out by proper management, and not by excision.

APO 757, New York.

REFERENCES

1. Medical Statistics Division, Office of the Surgeon General, Department of the Army.

2. Department of Army, Medical Technical Bulletin 89, Sept. 16, 1955.

3. Graham, E. A.: The Year Book of General Surgery (1956-1957 Series), Chicago, The Year Book Publishers, Inc., 1957, p. 494.

4. Brearley, R.: Pilonidal Sinus: A New Theory of Origin, Brit. J. Surg. 43:62, 1955.

5. Downing, J. G.: Barber's Pilonidal Sinus, J. A. M. A. 148:1501, 1952.

6. Ewing, M. R.: Hair Bearing Sinus, Letters to the Editor, Lancet 1:427, 1947.

7. Matheson, A. D.: Interdigital Pilonidal Sinus Caused by Wool, Australian & New Zealand J. Surg. 21:76, 1951.

8. Patey, D. H., and Scarff, R. W.: Pathology of Postanal Pilonidal Sinus: Its Bearing on Treatment, Lancet 2:484, 1946.

9. Patey, D. H., and Scarff, R. W.: Pilonidal Sinus in Barber's Hand, with Observation on Postanal Pilonidal Sinus, Lancet 2:13, 1948.

10. Waisman, M., and Olivetti, R. G.: Pilonidal Sinus of Hand, A. M. A. Arch. Dermat. & Syph. 66:466, 1952.

11. Aird, I.: Pilonidal Sinus of Axilla, Brit. M. J. 1:902, 1952.

12. Redding, M. D.: Simultaneous Anterior and Posterior Pilonidal Cyst, Am. J. Surg. 92:666, 1956.

13. Smith, T. E.: Anterior or Perineal Pilonidal Cyst, J. A. M. A. 136:973, 1953.

14. Davage, O. N.: The Origin of Sacrococcygeal Pilonidal Sinuses Based on an Analysis of 463 Cases, Am. J. Path. 30:1191, 1954.

15. Gifford, H.: Role of Hair in the Pathogenesis of Postanal Pilonidal Sinus, Stanford M. Bull. 12: 185, 1954.

16. Klass, A. A.: The So-Called Pilonidal Cyst, Canad. M. A. J. 75:737-742, 1956.

17. Huston, J.: Personal communication to the author.

18. Kleitsch, W. P., and Cherry, L. D.: Pilonidal Sinus—Rational Scheme of Treatment, Mil. Surgeon 111:96, 1952.

19. Hardaway, R. M.: Pilonidal Cyst, Misnamed, Misunderstood, and Mistreated, U. S. Armed Forces M. J. 7:516, 1956.

Case Reports

Calcified Pseudocyst of the Spleen

GEORGE F. ASBURY, M.D., Bremerton, Wash.

Splenic cysts are bizarre entities which are of interest not only for their rarity but also for the mystery which surrounds their pathogenesis. In 800 splenectomies done at the Mayo Clinic, Pemberton [1a] found but 4 cases of splenic cyst (0.5%). Since the first report of cystic disease of the spleen by Andral [2] in 1829, less than 200 splenic cysts have been mentioned in the literature, of which about 40 have been calcified. The occurrence of a large solitary calcified cyst of the spleen is considered worthy of mention and represents the basis of this report.

Classification

Fowler [3] classified splenic cysts as dermoid, parasitic, and nonparasitic varieties. Dermoid cysts of the spleen resemble dermoids elsewhere and are extremely rare; parasitic cysts arise from involvement of the spleen by Echinococcus disease. Other cysts fall into the nonparasitic varieties and are divided into true cysts and pseudocysts, depending upon the presence or absence of a true epithelial lining. The true cysts include neoplastic cysts (angiomatous, lymphatic) and inclusion cysts. Pseudocysts constitute the majority of this group, have no true lining, and may be calcified.

Etiology and Pathogenesis

Although many theories have been propounded regarding the cause of these interesting lesions, the mechanism of their formation remains obscure. Among many factors mentioned in discussions of etiology, the only one considered consistently important is trauma. McClure and Altemeier [4] suggested that these lesions actually represent encysted hematomas, resulting from injuries which fail to tear the surface of the spleen but produce laceration of deeper vessels. In time a "blood cyst" is formed, with a fluid content surrounded by a fibrous wall, which may later become calcified. Ordinary organization of the hematoma is perhaps impaired by the peculiar anatomy of the splenic vascular tree, in which the vessels are almost entirely end-arteries, and there is little collateral circulation. It is possible that hemorrhage into the splenic pulp can occur without history of trauma, from other vascular accidents (embolism, thrombosis, etc.) and cysts arise. In an attempt to produce splenic cysts by impairment of the blood supply to the spleen, Martin et al.[5] ligated the splenic vessels in a number of experimental animals, but only infarcts were produced. It has been suggested that the congestion of the spleen during pregnancy may increase the incidence of splenic hemorrhage and account for the occurrence of more splenic cysts in women of childbearing age. Antecedent splenic disease (malaria, syphilis, typhoid, etc.) is probably important in that the splenomegaly associated with such disorders makes trauma to the spleen more likely.

Diagnosis

Most splenic cysts cause no symptoms, except those explained by the size and weight of the spleen and the compression of neighboring structures. They are usually discovered as left upper quadrant masses, with or without flaring of the left costal

Accepted for publication Aug. 5, 1957.

margin. They lie anteriorly and tend to displace the stomach medially and the splenic flexure of the colon downward. Most important differential diagnostic lesions are cysts of the kidney, pancreas, and left lobe of the liver. Omental or mesenteric cysts may also occur.

Report of a Case

A 33-year-old white housewife was admitted to the hospital on March 8, 1957, because of irregular spells of upper abdominal discomfort, nausea, and vomiting of three months' duration. She had lost 25 lb. (11 kg.) in weight. Symptoms were not clearly related to the ingestion of food and were somewhat affected by changes in position. Diabetes mellitus, present since the age of 21, had always been troublesome and difficult to manage. The presence of a calcified mass in the left upper quadrant of the abdomen had been known for eight years; it had been discovered at fluoroscopy of the chest for an unrelated condition.

Past History.—The patient had borne four children. A total hysterectomy had been done at the age of 21 for "cancer." There was no other history of abdominal or thoracic trauma. She had lived in the Pacific Northwest all her life.

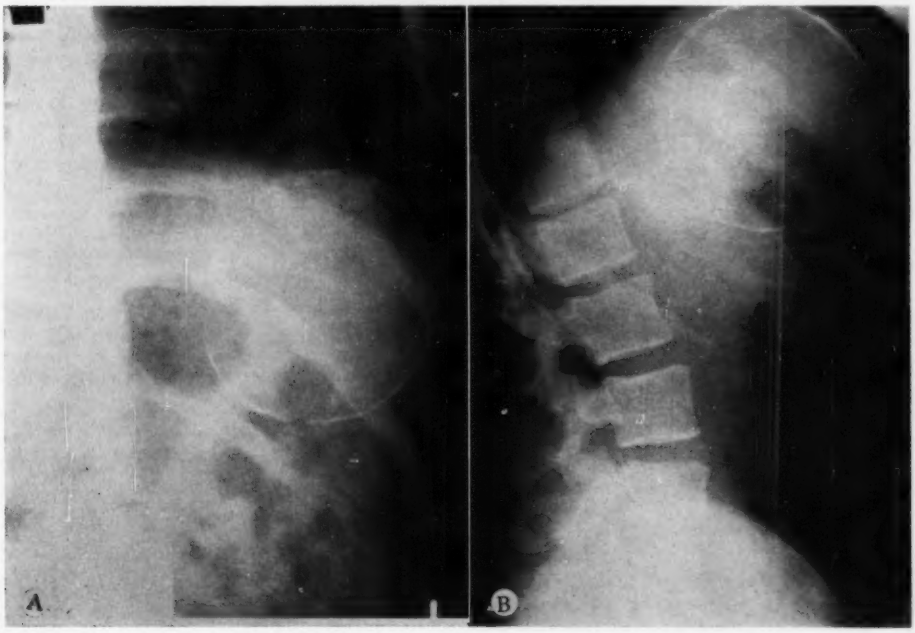
Physical Examination.—The patient was well developed but slender; she weighed 110 lb. (49.5 kg.). There were no remarkable physical defects except for a well-healed lower abdominal scar and absence of the uterus. Repeated attempts by several observers to palpate a mass in the left upper abdomen were unsuccessful. There was no flaring of the left costal margin.

Laboratory Studies.—The hemogram and urinalysis were normal except for moderate glucosuria. X-rays of the abdomen (Fig. 1) showed a rounded, calcified mass high in the left upper quadrant. Barium meal (Fig. 2) indicated displacement of the fundus of the stomach downward and to the right. No intrinsic lesion of the stomach or duodenum was demonstrated.

Hospital Course.—Diabetes was brought into control over several days by careful medical management. On March 14 operation was performed.

Operation.—The abdomen was opened through a long upper midline incision extending to the left of the umbilicus. Careful exploration revealed no abnormalities except for absence of the uterus and a large cystic mass within the substance of the spleen. The mass was firmly adherent to the lower surface of the left lobe of the liver and displaced the fundus of the stomach downward and to the right. The gastrocolic omentum was

Fig. 1.—*A*, plain anteroposterior film of abdomen shows calcified outline of splenic pseudocyst. *B*, lateral film shows calcified mass to be anteriorly placed.



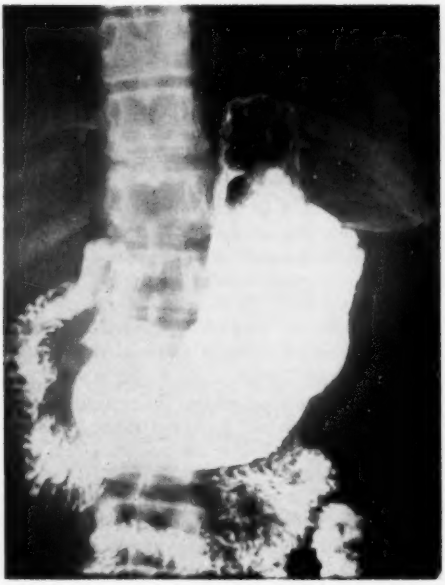


Fig. 2.—Barium meal indicates displacement of the fundus of the stomach downward and to the right by extrinsic pressure.

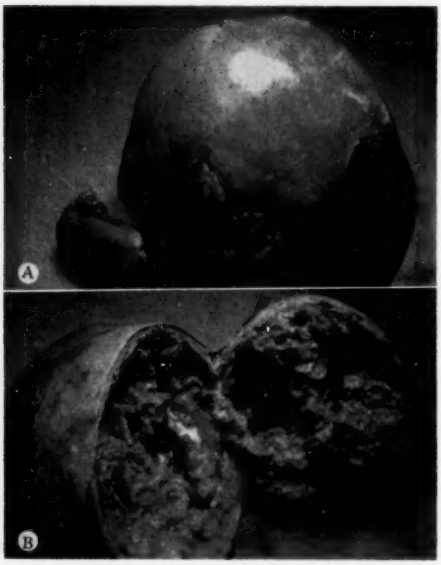


Fig. 3.—*A*, photograph of gross specimen shows rounded outline of splenic pseudocyst. *B*, the opened cyst contains brown fluid and amorphous material.

divided and the splenic vessels individually secured and ligated near the tail of the pancreas. The spleen was then delivered, carefully freed from the left lobe of the liver, and excised. The abdomen was closed with steel-wire sutures. The postoperative course was complicated by severe diabetic acidosis, but control was soon regained, and she left the hospital on the 10th day following operation.

Pathology (Fig. 3).—The spleen weighed 440 gm. On its anteromedial surface was a huge cyst, measuring 10 cm. in diameter; the wall of the cyst was markedly calcified. The cyst contained brown fluid and a great deal of amorphous material. Microscopic examination showed some arteriolar sclerosis but no other disturbance of splenic architecture. The material from the cyst showed some cholesterol crystals and ghost-like remnants of erythrocytes. Special smears and preparations failed to demonstrate evidence of parasites or fungi. The wall of the cyst was made up of calcified fibrous tissue.

The diagnosis was "calcified pseudocyst of the spleen, probably old, peripherally organized hematoma."

Summary

Primary cystic disease of the spleen is an interesting and rare entity. It should be considered in the diagnosis of calcified lesions in the left upper abdominal quadrant. A case of a large, solitary, calcified pseudocyst of the spleen is presented, together with a brief discussion of incidence and etiology.

205 Medical-Dental Building.

REFERENCES

1. Roberson, F.: Solitary Cysts of the Spleen, Ann. Surg. 111:848-850 (May) 1940.

1a. Pemberton, J. deJ., in discussion on Roberson.[1]

2. Andral, G.: Précis d'anatomie pathologique, Paris, Fortin, Masson & Cie, 1829, p. 432.

3. Fowler, R. H.: Cysts of Spleen, Ann. Surg. 57:658-690 (May) 1913.

4. McClure, R. D., and Altemeier, W. A.: Cysts of the Spleen, Ann. Surg. 116:98-102 (July) 1942.

5. Martin, J. D., Jr.; Zega, E. L., and Adamson, N. E., Jr.: Calcified Cyst of the Spleen, with Preliminary Report of Experimental Occlusion of Blood Supply of Spleen, Ann. Surg. 131:765-773 (May) 1950.

Leiomyosarcoma of the Spermatic Cord

Report of a Case and Review of the Literature

KENNETH CRUZE, M.D., Los Angeles

Introduction

Primary leiomyosarcoma of the spermatic cord is so rare that its occurrence deserves reporting. There has been limited follow-up observation in the cases reported to date. However, in the case of Sherwin [1] there was a follow-up until death, but no autopsy. In two other cases, those of Cannon [2] and of Thompson,[3] the patients were still living at the time of reporting. An exhaustive review of the literature by various authors has resulted in the compilation of a growing number of tumors. A review by Fitzpatrick et al.[4] in 1952 and by Cannon, Altheide, and Allen [2] in 1954 showed that there had been only six previously reported cases of primary leiomyosarcoma of the spermatic cord. In the following case the tumor was unsuspected before surgery and apparently had not extended to other portions of the body.

Report of Case

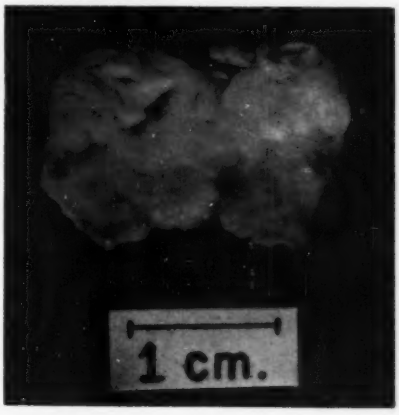
A 53-year-old Negro was first admitted on Sept. 11, 1956, for repair of a left inguinal hernia, of three months' duration. During this time he had noticed an intermittent "dragging" sensation in the left inguinal region, which was mildly uncomfortable. The patient denied having had any urinary complaints, trouble with breathing, change in bowel habits, or injection treatment for the hernia. Both testes had fully descended into the scrotum at birth.

Physical examination revealed a 4×5×2 cm. suboccipital lipoma, and internal hemorrhoid, and a left inguinal hernia, protruding 3 cm. below the external ring on straining. The testes and spermatic cords were normal to palpation.

Laboratory studies done before surgery, including the VDRL test for syphilis, routine urinalysis, hemoglobin determination, white and red blood cell counts, and skull x-rays, were normal. Other laboratory data obtained after the hernia repair, but before the second operation, included an upper gastrointestinal x-ray series; intravenous urogram; venocavagram; sigmoidoscopic findings; total protein and A/G ratio; acid and alkaline phosphatase; sulfobromophthalein (Bromosulphalein) retention; cephalin flocculation; thymol turbidity; serum sodium, potassium, and chloride levels; blood urea nitrogen, and carbon dioxide-combining capacity. They were all normal.

On Sept. 17, during repair of the left indirect inguinal hernia, a 1×2×1 cm., yellowish-white, firm, nodular lesion (Fig. 1) was noted within the midportion of the spermatic cord. This was dissected out bluntly with ease and the surgical procedure completed. The postoperative course was uneventful. Microscopic examination (Figs. 2, 3, 4, and 5) revealed the tumor to be a leiomyosarcoma. On Oct. 8, after other significant laboratory data were completed, an en bloc removal of skin, fascia, spermatic cord, inguinal canal, left testis, and retroperitoneal lymph nodes was per-

Fig. 1.—Cut surfaces of gross specimen. Note the circumscribed outer border.



Submitted for publication May 31, 1957.

Resident in general surgery, Wadsworth General Medical and Surgical Hospital.

From the Surgical Service, Wadsworth General Medical and Surgical Hospital, Veterans' Administration Center.

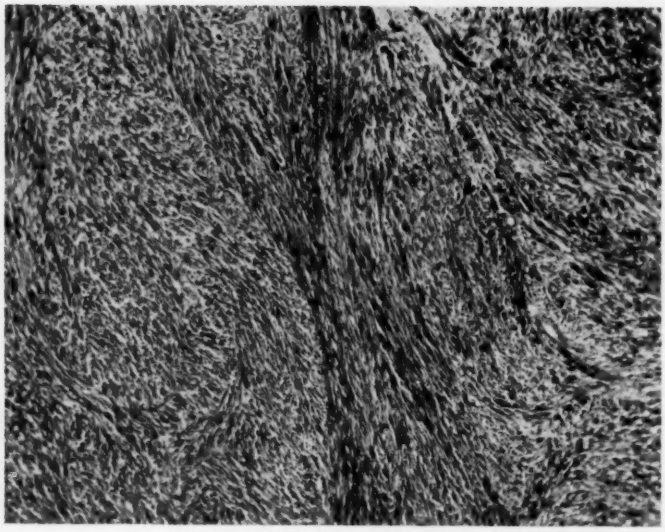


Fig. 2.—Section of tumor showing mitotic figures in muscle bundles. Heidenhain's iron hematoxylin stain; × 100.

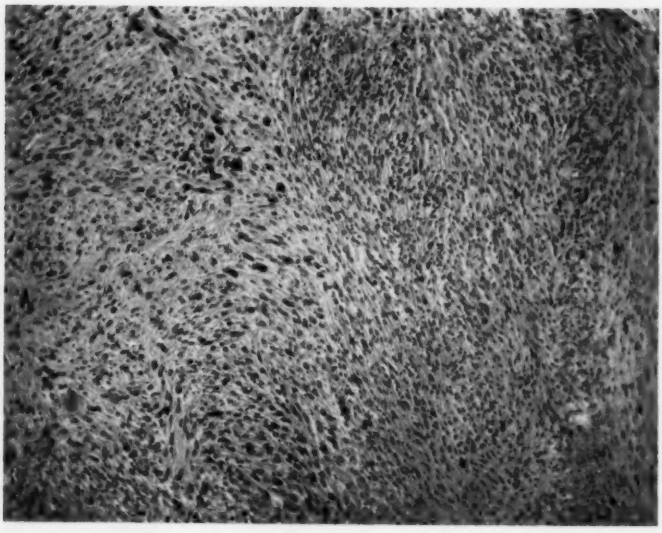


Fig. 3.—Section showing marked anaplasia of nuclei. Hematoxylin and eosin stain; × 100.

formed. Microscopic examination of the specimen, after multiple sections were made, showed no extension in any area. The postoperative course was good except for moderate drainage from the left inguinal incision and scrotum. The patient was discharged, to be followed by the Tumor Board. At the present time, nine months after operation, there has been no evidence of extension or recurrence and no indication of another primary site. Hence the spermatic cord is considered to have been the primary site.

Comment

This case is unusual because the tumor was detected at operation and was not felt on physical examination. Because the tumor was small and a wide excision was done, a better prognosis can be made. It is interesting to note that all of the reported tumors were palpated on physical examination and a nonspecific diagnosis of a mass

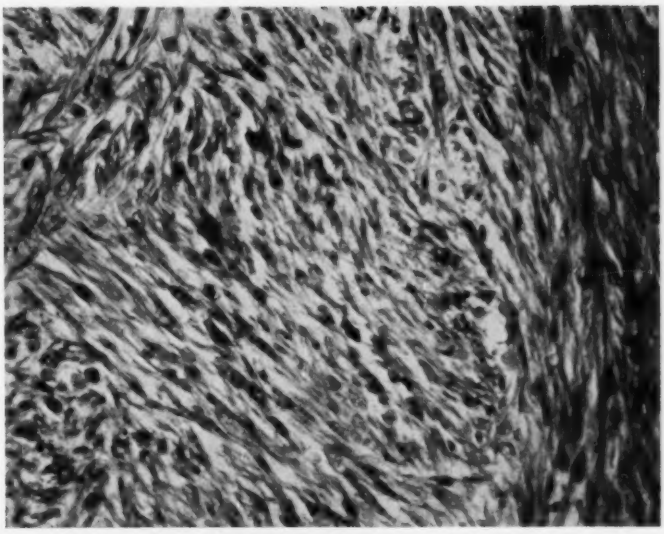


Fig. 4.—Section showing anaplasia with cellular detail. Heidenhain's iron hematoxylin stain; × 400.

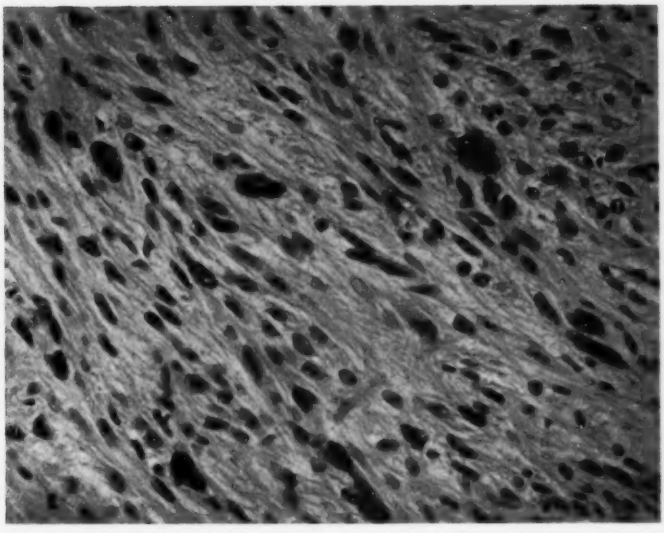


Fig. 5.—Section showing nuclear detail. Hematoxylin and eosin; × 400.

was made preoperatively. The differential diagnosis of tumors of the spermatic cord includes lipomas, inguinal hernia, hydrocele, spermatocele, cyst of the cord, varicocele, and granulomatous disease. Because of the possibility of a solid tumor in this area, the final diagnosis should always rest with the histopathologist. A rapid review of the histology of the spermatic cord brings to mind the fact that it contains not only connective tissue, blood vessels, and nerves but also the vas deferens and smooth and skeletal muscle fibers. Recent statistics [2,4,7] seem to agree with Thompson's [3] observation that approximately 70% of all primary spermatic cord masses are benign. These tumors pose a problem in determining the best method of treatment, since sarcomas more frequently metastasize by the blood stream and tend to be radioresistant.

Reported Leiomyosarcomas of the Spermatic Cord

	Surgery	X-Ray	Radium	Recurrences	Follow-Up
Sherwin and Bergman [1]	Dec. 3, 1945: Orchiectomy and spermatic cord removed Aug. 17, 1946: Dissection of groin	Jan., 1946: 4500 r Oct., 1946: 300 r Nov., 1946: 2400 r	None	2	Died at home; no autopsy April 8, 1956
Cannon et al. [2]	Feb. 20, 1950: Orchiectomy at internal ring March 2, 1951: En bloc node dissection—inguinal and femoral	March 1950: 1620 r	None	1	No recurrence by Aug. 2, 1954
Thompson [3]	1914 and 1917: Type unknown Dec. 20, 1920: Removed cord and testis Aug. 24, 1923: Wide excision	1917: After surgery Oct., 1920 1923: After surgery High voltage	Oct., 1920 1920: After surgery	3	No recurrence at time of reporting, in 1936
Wessel [5]	Jan. 14, 1952: Tumor mass excised	None	None	Unknown	None
Herbut [6]	Surgery, type, and date unreported; nothing else known				
Schulte [7]	Nothing known of one case; other case recorded is that of Thompson [3]				

A compilation of the previously reported cases of leiomyosarcoma of the spermatic cord is presented (Table).

Summary and Conclusions

This case represents an almost incidental histopathological diagnosis of an exceedingly rare tumor.

All grossly innocuous-appearing firm nodules should be removed from the spermatic cord and sent for microscopic diagnosis. This may be a life-saving procedure.

Wide local surgical removal of the tumor plus a radical node dissection would seem to constitute the best treatment.

Since present reports indicate frequent recurrence, careful and prolonged follow-up should be carried out.

Because of limited knowledge, and since it is evident that metastases are not rare and may occur late, the prognosis remains guarded.

1514 Yale St., Santa Monica, Calif.

REFERENCES

1. Sherwin, B., and Bergman, H.: Primary Malignant Neoplasms of the Spermatic Cord and Epididymis: Two Case Reports, J. Urol. 67:208-215 (Feb.) 1952.

2. Cannon, E. M.; Altheide, J. P., and Allen, H. C.: Malignant Tumors of the Spermatic Cord and Testicular Tunics, South. M. J. 49:17-24 (Jan.) 1956.

3. Thompson, G. J.: Tumors of the Spermatic Cord, Epididymis and Testicular Tunics: Review of Literature and Report of 41 Additional Cases, Surg. Gynec. & Obst. 62:712-728 (April) 1936.

4. Fitzpatrick, R. J.; Orr, L. M.; Glanton, J. B., and Hayward, J. C.: Tumors of the Spermatic Cord: Review of Literature and Report of 2 Cases, J. A. M. A. 148:259-261 (Jan.) 1952.

5. Wessel, H. N.: Leiomyosarcoma of the Spermatic Cord, J. Urol. 69:823-829 (June) 1953.

6. Herbut, P. A.: Urological Pathology, Philadelphia, Lea & Febiger, 1952, Vol. II, p. 1032.

7. Schulte, T. L.; McDonald, J. R., and Priestley, J. T.: Tumors of the Spermatic Cord: Report of Case of Neurofibroma, J. A. M. A. 112:2405-2406 (June 10) 1939.

Cystic Lymphangioma of the Mesentery

Review of the Literature and Report of a Case

JACK A. LAWSON, M.D.; RONALD B. DIETRICK, M.D., and SIMON RUSSI, M.D., Richmond, Va.

The report of unusual cases is justified because each report adds to the accumulated knowledge of a specific problem. With this in mind, we wish to report a mesenteric cyst which proved microscopically to be a cystic lymphangioma.

The mesenteric cyst has been known since the Middle Ages, when one was described at autopsy by Benevieni, of Florence, in 1507.[1] However, his description is extremely sketchy. Rokitansky[2] apparently first described the chylous mesenteric cyst, i. e., cystic lymphangioma, in 1842. Since then many mesenteric cysts, chylous and otherwise, have been reported. Their rarity is attested to by the fact that Beahrs and Judd[3] found only 174 cysts of the omentum, mesentery, and retroperitoneal region in more than 1,000,000 patients at the Mayo Clinic, and of those at least 7 were chylous. Flynn[4] said mesenteric cysts are the rarest of all abdominal tumors. The case reported here is the first found in over 80,000 admissions to this hospital.

Report of Case

A 56-year-old Negro was admitted to the gastroenterology section of Veterans' Administration Hospital on Oct. 22, 1956. He gave a history of "stomach trouble" of two months' duration, with a 15 lb. (6.5 kg.) weight loss over this period. He had had anorexia over this period and complained of "an unsettled feeling" in the epigastric region, fullness in the lower chest, and sour eructations after meals. He was hospitalized in another hospital one and one-half months prior to admission here, where a barium meal and barium enema were unrevealing.

Submitted for publication June 25, 1957.

From the Departments of Surgery and Pathology, Veterans' Administration Hospital.

Physical Examination.—The findings were not remarkable except for prominent dilated veins over the abdomen and a sense of fullness to palpation throughout the abdomen.

Laboratory Studies.—Routine hematologic studies and urinalysis were normal.

X-Ray Examinations.—Intravenous pyelogram was negative. A barium enema study was normal. The report on a barium meal was as follows: "There is no abnormality of the stomach and small bowel per se other than that the intestine seems to be displaced cephalad and toward the flanks, probably by a large mass occupying the lower abdomen" (Fig. 1).

Operation and Findings.—The patient was seen in consultation by the general surgical service, and, in addition to the above findings, a cystic mass was felt high through the anterior rectal wall. At this time the patient also stated that when he turned in bed he noted a "slushing feeling" in his abdomen, as if something were moving about.

The patient was advised to have an exploratory laparotomy. The preoperative diagnosis was a cystic abdominal mass, probably arising from the retroperitoneal space or intestinal mesentery. He was transferred to the surgical service and on Nov. 27, 1956, exploration was performed. A large cystic mass, measuring about 30×20×20 cm., was found arising within the mesentery of the ileum about 45 cm. from the ileocecal valve. The major portion of the cyst was inferior, with a small globular portion projecting through the mesentery to the superior surface, and measuring approximately 4×5×5 cm., with a neck 5 cm. in diameter attaching it to the remainder of the cyst (Fig. 2). The cyst was aspirated of 1500 cc. of thick milky fluid, which clotted rapidly, and was then removed by dividing its attachments to the mesentery. The defect in the mesentery of the terminal ileum was closed, and an appendectomy was performed. Postoperatively the patient made an uneventful recovery and was discharged symptom-free on the 10th postoperative day.

Laboratory examinations on the unclotted portion of the fluid from the cyst revealed protein 4.5 mg. per 100 cc. Fat globules were seen on direct examination, and ether extractions indicated considerable fat. Bacteriological cultures showed no growth.

Fig. 1.—Anterior-posterior view after barium meal, showing upward and lateral displacement of intestine by the cyst.

Pathology Report.—The specimen was a collapsed, somewhat irregularly spherical cystic structure about 15 cm. in diameter. The external surface was fairly smooth except for scattered tags of adipose and thin membranous tissue. The wall of the cyst measured from 1 to 12 mm. in thickness, the thinner portions appearing translucent. The lumen contained creamy, opalescent liquid. The inner surface was trabeculated with coarse and fine ridges crisscrossing in various directions. In many instances the ridges radiated from slightly elevated, silvery white knots. Ridges from adjoining knots frequently formed a basket-weave pattern (Fig. 3).

Fig. 2.—Cyst at operation, before it was aspirated.

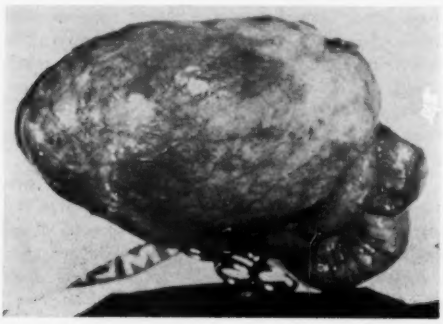
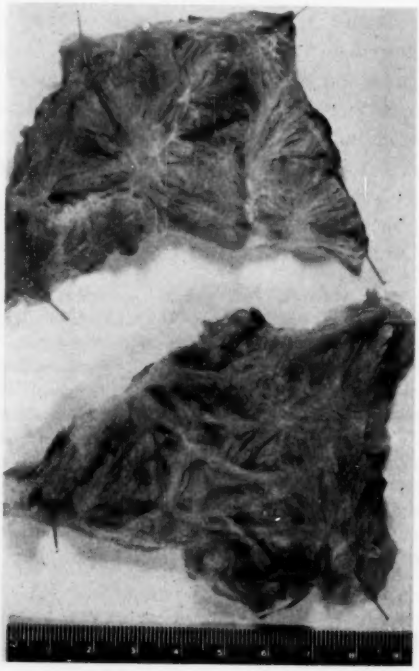


Fig. 3.—The specimen opened, showing the trabeculated inner surface.



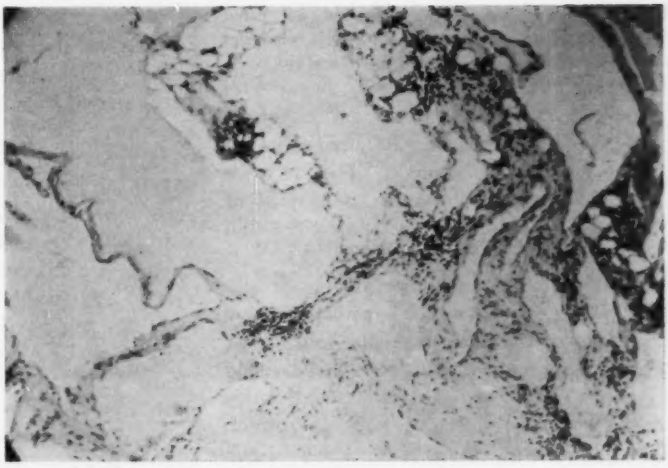


Fig. 4.—Photomicrograph of the cyst wall, showing the endothelial-lined channels, and the fibromuscular wall containing islands of adipose tissue.

Histologic sections taken from several segments of the cystic wall were stained with hematoxylin and eosin and with the Verhoeff-Van Gieson method. The thicker portions of the wall showed an aggregate of irregular vascular spaces lined by flat endothelium and containing a homogeneous eosinophilic material. The spaces were separated by septa made up of fibrous tissue interspersed with islands of adipose tissue. There were, also, some strands of smooth muscle and collections of lymphocytes (Fig. 4). The ridges visible in the lining of the cyst were made up almost entirely of muscular strands. The knots from which the strands radiated were made up of dense, relatively acellular, fibrocollagenous tissue (Fig. 5).

The pathologic diagnosis was cystic lymphangioma of the mesentery.

The appendix showed slight lymphocytic and polymorphonuclear leukocytic infiltration in the subserosa and was classified as acute periappendicitis.

Etiology and Classification

Various classifications of mesenteric cysts have been suggested over the past 50 years. One of the first, if not the first, classification according to the origin of the cyst was by Dowd in 1900, who classified these cysts as (1) embryonic, (2) hydatid, and (3) malignant.[5]

Dowd further stated[5]:

Reports indicate that mesenteric cysts are being removed as often as once a month. If microscopical

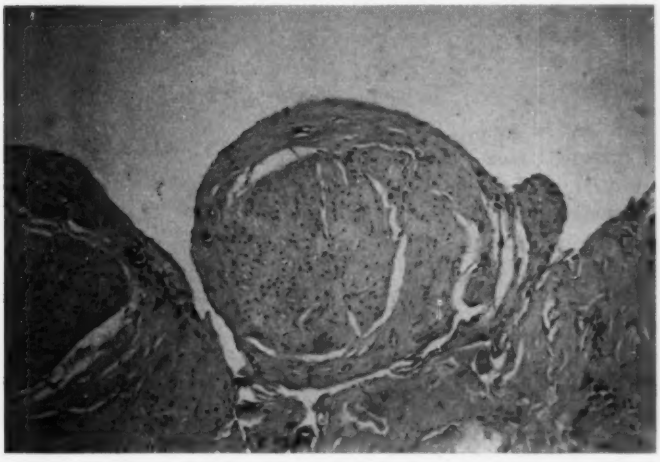


Fig. 5.—Photomicrograph, showing one of the "knots" of fibrocollagenous tissue, from which the trabeculations of the cyst wall radiated.

examinations of the cyst walls, and chemical and microscopical examinations of the cyst fluid are made, the entire subject should soon be understood. Unfortunately, cases are still being presented in the literature without either of these suggestions being followed, and in 1948 Vaughn et al.[6] stated: "The literature contains many theories as to the genesis of mesenteric cysts but the subject is still rather confusing."

Peterson[7] divided mesenteric cysts into two groups, the first being embryonic and the second pseudocysts. The embryonic group is composed of (*a*) cysts arising from embryonic remnants and sequestrated tissue, and (*b*) cysts of intestinal origin. The pseudocysts were of infective origin, i. e., tuberculous and hydatid; or neoplastic, i. e., cystic malignant disease.

All of the more recent classifications of true or embryonic mesenteric cysts sharply divide those cysts arising from the bowel and those arising elsewhere. Of these classifications, Ewing's[8] is both simple and workable. He classifies mesenteric cysts as follows: (1) lymphatic or chylous; (2) enteric; (3) urogenital; (4) dermoid and teratoids. Klemm and Rittner, cited by Ewing, believe that all chylous mesenteric cysts are cystic lymphangiomas. Thus, we would classify our case as a chylous cyst, or a cystic lymphangioma of the mesentery. Pathogenetically, it is our feeling that it is a mesenchymal hamartoma with vascular, smooth muscle, adipose, and lymphoid elements represented.

Diagnosis and Treatment

In such rare tumors a variety of nonspecific symptoms would be expected. However, some statistical facts, certain signs, symptoms, and laboratory studies are of value. In a collected study by Burnett et al.,[9] including the case histories of 71 cases, "pain of some nature" was present in 81.5% of cases, nausea and vomiting in 45%, and a palpable mass in 58%. Others have noted the frequency of a palpable mass and of pain.[10,11] In addition, a high incidence of intestinal obstruction has been observed.[11,12] In diagnosis, at least two authors suggest an intravenous pyelogram to rule out a kidney lesion.[6,13] It has also been observed that barium meal may show displacement of the intestine, as it did in our case.[13] From the more recent reports in the literature, it would seem these cysts are most frequently seen in children, though in Burnett's series only 52% were under 30. Interestingly enough, we did not find a report of such a cyst in a Negro.

In Burnett's collected series, 87 patients were treated by enucleation, with a mortality of 6.9%; 44 were treated by resection, with a mortality of 15.9%; 23 were treated by marsupialization, with a mortality of 4.4%; 8 were treated by drainage, with a mortality of 60.0%, and 6 by aspiration with a mortality of 33.3%.[9] Vaughn states that total removal or enucleation is the operation of choice, and in general this seems to be the most frequent method of attack in recent years.[6] He further states that aspiration is to be condemned. Though marsupialization carried the lowest mortality in Burnett's series, it is objectionable because of the prolonged period in which there is a draining sinus and because the sinus may not close.

Summary

A case of cystic lymphangioma of the mesentery is presented. Though mesenteric cysts have been known since 1507, they are yet a rare and confusing entity.

Ewing's classification is given as an example of one which is both simple and comprehensive.

Various factors pertaining to diagnosis are outlined briefly, among these being the high incidence of abdominal pain, 81.5%, and of a palpable mass, 58%.

Enucleation is the treatment of choice.

Veterans' Administration Hospital (19) (Dr. Dietrick).

REFERENCES

1. Benevieni, A.: De abditis nonnullis ac mirandis morborum et sanationum causis, Florence, The Guinti, 1507; translated by Charles Singer with

a Biographical Appreciation by Esmond R. Long, Springfield, Ill., Charles C Thomas, Publishers, 1954, Ref., p. 81.

2. von Rokitansky, C.: Lehrbuch der pathologischen Anatomie, Vienna, Braunmüller u. Seidel, 1842.

3. Beahrs, O. H., and Judd, E. S.: Chylangiomas of the Abdomen: Report of Case, Proc. Staff Meet. Mayo Clin. *22*:297, 1947.

4. Flynn, C. W.: Mesenteric Cysts, with Report of Case of Cystic Lymphangioma, Ann. Surg. 91: 505, 1930.

5. Dowd, C.: Mesenteric Cysts, Ann. Surg. *32*: 515, 1900.

6. Vaughn, A. M.; Lees, W. M., and Henry, J. W.: Mesenteric Cysts: Review of Literature and Report of Calcified Cyst of Mesentery, Surgery *23*:306, 1948.

7. Peterson, E. W.: Cysts of the Mesentery, Ann. Surg. 112:80, 1940.

8. Ewing, J.: Neoplastic Diseases, Ed. 4, Philadelphia, W. B. Saunders Company, 1942, p. 1062.

9. Burnett, W. E.; Rosemond, G. P., and Bucher, R. M.: Mesenteric Cysts, Arch. Surg. 60: 699, 1950.

10. Gross, R. E.: The Surgery of Infancy and Childhood, Philadelphia, W. B. Saunders Company, 1953.

11. Handelsman, J. C., and Ravitch, M.: Chylous Cysts of the Mesentery in Children, Ann. Surg. 140:185, 1954.

12. Roller, C. S.: Mesenteric Cysts: Brief Discussion and Report of 3 Cases, Surg. Gynec. & Obst. 60:1128, 1935.

13. Wood, K.: Lymphatic Cysts of the Mesentery, Brit. J. Surg. 43:303, 1955.

Mammary Carcinoma Followed After Twenty-Eight Years by Primary Malignant Pleural Mesothelioma

R. DREW MILLER, M.D.; MALCOLM B. DOCKERTY, M.D., and WARREN A. BENNETT, M.D., Rochester, Minn.

Carcinoma of the breast in childhood is exceedingly rare. Numerous relatively recent reviews [1-6] of malignant tumors in children do not mention it, although several case reports of mammary carcinoma in children appeared in the medical literature between 1897 and 1926.[7-10] However, the reports that contained illustrations or detailed descriptions of the histologic appearance of the tumors concerned children 12 years of age or older.

Primary malignant pleural mesothelioma is also rare, being considerably less common than the localized benign variety.[11-15] The varied histologic pattern in many malignant pleural tumors reported in the earlier medical literature led Robertson [15] to conclude reasonably that many of them were actually metastatic carcinomas rather than primary pleural tumors. Nevertheless, occasional well-documented primary malignant pleural mesotheliomas have been reported.[12,14]

The patient herein reported on is of particular interest because she had two different malignant neoplasms under unusual circumstances. An adenocarcinoma of the right breast was found at the age of 4 years, and a fatal primary malignant mesothelioma was discovered at necropsy, at the age of 32. The occurrence of two such rare tumors in one person warrants mention.

Submitted for publication June 28, 1957.

Section of Medicine (Dr. Miller); Section of Surgical Pathology (Dr. Dockerty); Section of Pathologic Anatomy (Dr. Bennett), Mayo Clinic and Mayo Foundation. The Mayo Foundation, Rochester, Minn., is a part of the Graduate School of the University of Minnesota.

Report of Case

A 32-year-old single white woman, a practical nurse, entered the hospital in April, 1956. Eleven months previously she had noted pain across both shoulders associated with fever requiring confinement at home for 11 days. Subsequently, she had noted momentary twinges of pain in the scapular regions. Severe persistent pain in the left anterior part of the thorax recurred one month prior to registration. She had received penicillin, tetracycline (Achromycin), and erythromycin (Erythrocin) in sequence and had required codeine for partial relief of the pain. High fever had occurred each day, associated with tenderness over the left hemithorax, shortness of breath, and a slight nonproductive cough. Thoracentesis on four occasions had produced bloody fluid, ranging in volume from 200 to 260 ml.

When the patient was 4 years of age, a nodule had been removed from the right breast by her family physician and sent to Dr. Broders, of the Mayo Clinic, for evaluation. The histologic diagnosis had been adenocarcinoma, Grade 3. These slides had remained at the Clinic; they were reviewed, and the diagnosis was reaffirmed when the patient came in April, 1956. Because a mass again had appeared in the right pectoral region one year after the original excision, radical right mastectomy had been performed. The patient had had a thyroidectomy in 1944 and again in 1948.

Examination in April, 1956, revealed a seriously ill, pale, perspiring woman. The pulse was 92 and regular and the temperature 103.6 F. The percussion note was flat over the lower three-fourths of the left hemithorax, and the breath sounds were absent. A few high-pitched inspiratory rales were heard above this region. A Grade 2 systolic basilar cardiac murmur was noted. The edge of the liver was palpable 3 fingerbreadths below the right costal margin. The spleen could not be palpated.

The hemoglobin concentration of the blood was 7.9 gm. per 100 ml. Erythrocytes numbered 3,430,000 cells per cubic millimeter of blood, and the leukocyte count was 35,200. Smears of the peripheral blood revealed 83.5% neutrophils, 9.5% monocytes, and 7% lymphocytes, with toxic changes, pronounced rouleau formation, some

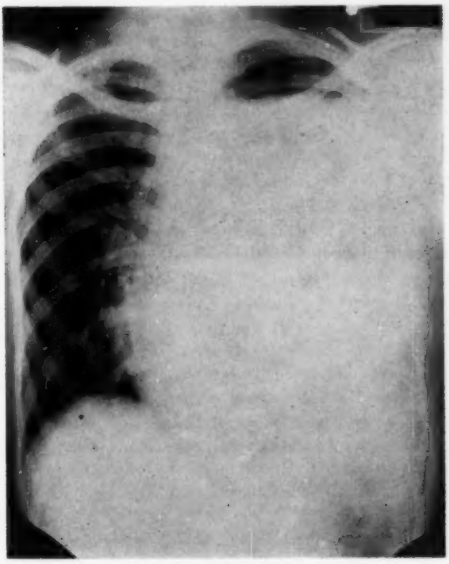


Fig. 1.—Diffuse left thoracic opacity, with presence of a fluid level.

anisocytosis, and polychromasia. The erythrocytic sedimentation rate was 127 mm. during the first hour (Westergren method). Urinalysis revealed albumin, Grade 2; a few hyaline and granular casts, and a few erythrocytes and pus cells. The serum albumin measured 3.09 gm. per 100 ml., and the globulin was 2.53 gm. The Quick prothrombin time was 26 seconds (normal is 18 to 20 seconds). Examination of a hanging-drop smear of the blood showed reticuloendothelial cells but no phagocytic forms. Study of aspirated bone marrow revealed normal activity with no diagnostic changes. A few aggregations of polymorphonuclear cells were scattered throughout. No granulomatous lesions were seen. A roentgenogram of the thorax revealed extensive pleural effusion on the left, with hydropneumothorax (Fig. 1). A fluid level extended to the fourth rib posteriorly. An electrocardiogram revealed sinus tachycardia, with a ventricular rate of 133 per minute. The Q-T interval was 0.32 second. The T-waves were positive from V-1 through V-6.

A thoracentesis was carried out through the left sixth interspace in the midscapular line. A total of 550 ml. of dark serosanguineous fluid was obtained. Because of apparent pleural thickening and loculation of the bloody pleural effusion, attempts at lower levels were unsuccessful in obtaining pleural fluid. Examination of the pleural fluid did not reveal any malignant cells. Culture of the fluid for pathogens, fungi, and acid-fast bacilli gave negative results.

Antibiotics were not given initially. During the first four days the temperature gradually decreased to 100 F. On the fourth day the temperature varied from 100 to 102 F and the pulse rate from 110 to 140 beats per minute.

Culture of nine samples of blood, obtained over a period of nine days, failed to give any growth of pathogens. Several more attempts were made to aspirate fluid from the left hemithorax, but, owing to organization of the effusion, no more fluid was obtained. Needle biopsy of the liver disclosed normal parenchyma. Because of the patient's critical state and the appearance of hypotension, hydrocortisone was given in doses ranging from 25 to 75 mg. daily; 100 mg. of oxytetracycline (Terramycin) was administered every six

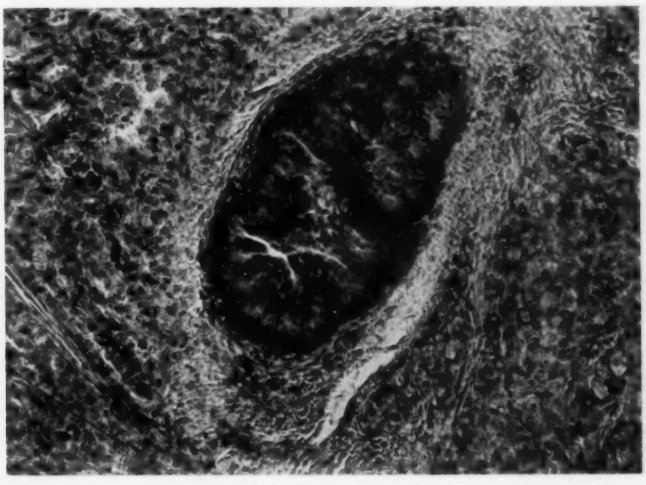


Fig. 2.—Original carcinoma of the breast, with a duct filled with malignant cells and diffuse cording of infiltrating tissue. Carcinoma is present in the surrounding tissue. Hematoxylin and eosin; × 150.

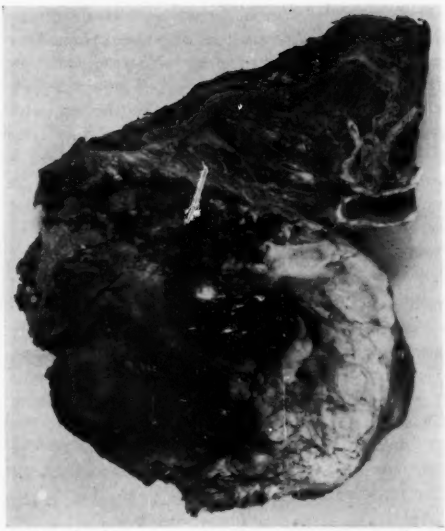


Fig. 3.—Necropsy specimen showing the large necrotic tumor of the pleura, with encasement and compression of the adjacent pulmonary parenchyma.

hours, and 400,000 units of penicillin with 0.5 gm. of dihydrostreptomycin was given twice daily intramuscularly for antibiotic coverage of the steroid drug. The patient became progressively weaker and more dyspneic; despite transfusions of whole blood, she died 17 days after admission.

Surgical Findings.—The original tumor of the breast was manifestly malignant, as evidenced by pronounced cellularity and the presence of mitotic figures (Fig. 2). It was difficult to be sure in some sections that the growth was a carcinoma, and not a sarcoma, but the tendency of the individual tumor cells to be arranged in single file strongly favored the former interpretation. Moreover, as illustrated in the center of Figure 2, parts of the tumor gave evidence of malignant proliferation of epithelial cells that could be identified as being ductal in origin. This picture, often duplicated in comedocarcinoma, is accepted as evidence of primary, as opposed to metastatic, involvement and of epithelial, rather than connective tissue, histogenesis.

Necropsy Findings.—Necropsy revealed a tumor, measuring 15×14×10 cm., in the left hemithorax, adherent to and compressing the lung (Fig. 3). A thick, shaggy layer of partly organized, clotted blood covered the entire visceral and parietal pleurae. The tumor was grayish white, soft, and friable, and the outer portions were hemorrhagic. The lower lobe of the left lung was completely compressed and collapsed, and the upper lobe was partially compressed. The right lung was somewhat compressed by the shifted mediastinum. Numerous small pulmonary emboli with peripheral infarcts were present. The hilar nodes did not contain tumor.

The liver extended 8 cm. below the xiphoid and 5 cm. below the right costal margin. A clot, containing 30 ml. of blood, was located below the right lobe. The left lobe appeared darker than the right, and the left hepatic vein contained a large thrombus.

A thrombus also was found in the right iliac vein. The heart, gallbladder, pancreas, stomach, intestine, kidneys, and adrenals were essentially normal.

Microscopic examination of the intrathoracic tumor revealed changes compatible with a diagnosis of pleural mesothelioma (Fig. 4). No tumor tissue was found that could be considered to be related to the carcinoma of the breast removed 28 years before.

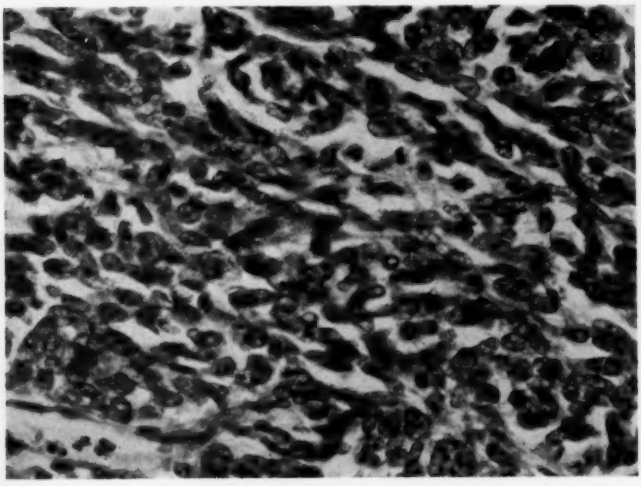


Fig. 4.—Pleural tumor composed of malignant spindle cells, with mitotic figures, disposed about slit-like spaces. Hematoxylin and eosin; ×440.

Comment

In the clinical approach to this diagnostic problem, the possibility of long-delayed metastasis from the primary mammary carcinoma was considered strongly. That such tardy metastasis does occur, especially in carcinoma of the breast, is generally appreciated. One might suggest this diagnosis despite the evidence present at necropsy. It appears evident, however, that the histologic appearance supports the contention that these two tumors were unrelated.

Certain terminal clinical features in this case were similar to those in cases of malignant pleural mesothelioma reported by others.[12-14] Rapid clinical progression, with pain, dyspnea, and terminal fever, apparently is characteristic of malignant pleural mesothelioma. Klemperer and Rabin [12] reported on a 26-year-old woman who had thoracic pain, dyspnea, rapid deterioration, and terminal high fever. Stout and Murray [13] reported a similar case in a 43-year-old woman who had a somewhat more protracted course. Bogardus and associates [14] reported on a 3-year-old girl who had sore throat, fever, pain, dyspnea, and a rapid demise.

Summary

A case is reported of a 32-year-old woman who had a fatal malignant pleural mesothelioma. When the patient was 4 years of age, 28 years prior to death, an adenocarcinoma of the right breast had been removed. No evidence of metastatic carcinoma was found at necropsy. The carcinoma of the breast, occurring at an extremely early age, appeared to be entirely unrelated to the primary pleural mesothelioma.

REFERENCES

1. Helmholz, H. F.: Malignant Neoplasms in Childhood, Proc. Staff Meet. Mayo Clin. 6:721-724 (Dec. 9) 1931.

2. Dargeon, H. W., Editor: Cancer in Childhood and a Discussion of Certain Benign Tumors, St. Louis, The C. V. Mosby Company, 1940.

3. Dargeon, H. W.: Cancer in Children from Birth to 14 Years of Age, J. A. M. A. 136:459-468 (Feb. 14) 1948.

4. Cancer Among Children, Statist. Bull. Metrop. Life Insur. Co. 30:5-8 (Jan.) 1949.

5. Videbaek, A.: Malignant Tumours in Childhood, Acta pædiat. 39:502-509, 1950.

6. Bufkin, J. H., and Davison, W. C.: Childhood Cancer (Tumors, Leukemia, and Hodgkin's Disease): A Review, J. Pediat. 42:612-632 (May) 1953.

7. Blodgett, A. N.: Cancer of the Breast in a Child, Boston M. & S. J. 136:611 (June 17) 1897.

8. Simmons, R. R.: Adenocarcinoma of the Breast Occurring in a Boy of 13, J. A. M. A. 68: 1899-1900 (June 23) 1917.

9. Blanc, D. Z.: Mammary Cancer in Infants; J. A. M. A. 70:905 (March 30) 1918.

10. Schultz, O. T.: Tumors of Infancy and Childhood, in Pediatrics, edited by Abt, I. A., Philadelphia, W. B. Saunders Company, 1926, pp. 641-865.

11. Clagett, O. T.; McDonald, J. R., and Schmidt, H. W.: Localized Fibrous Mesothelioma of the Pleura, J. Thoracic Surg. 24:213-230 (Sept.) 1952.

12. Klemperer, P., and Rabin, C. B.: Primary Neoplasms of the Pleura: A Report of 5 Cases, Arch. Path. 11:385-412 (March) 1931.

13. Stout, A. P., and Murray, M. R.: Localized Pleural Mesothelioma: Investigation of Its Characteristics and Histogenesis by the Method of Tissue Culture, Arch. Path. 34:951-964 (Dec.) 1942.

14. Bogardus, G. M.; Knudtson, K. P., and Mills, W. H.: Pleural Mesothelioma: Report of 4 Cases, Am. Rev. Tuberc. 71:280-290 (Feb.) 1955.

15. Robertson, H. E.: "Endothelioma" of the Pleura, J. Cancer Res. 8:317-375 (Oct.) 1924.

Retroperitoneal Liposarcoma with Hemorrhage

CLIFTON F. WEST Jr., M.D., Philadelphia

Liposarcoma is a relatively rare malignancy arising from lipoblasts. By virtue of their size, location, and extent these tumors frequently present many diagnostic possibilities and difficult surgical problems. Retroperitoneal liposarcomas tend to have a variable rate of growth, attain tremendous size, and recur locally after excision. They are frequently not attacked with the aggressiveness that their true nature warrants. The commonest sites for these retroperitoneal tumors are the perirenal fat, mesentery, and omentum.

Symptoms are usually vague, consisting of swelling of the abdomen and the presence of a mass. Bizarre gastrointestinal symptoms are common because of compression of neighboring organs. These tumors may produce pain, fever, tenderness, nausea, and vomiting associated with degeneration of the rapidly growing malignant variety. The diagnosis is frequently aided by intravenous or retrograde urinary-tract studies, with special emphasis on lateral views to demonstrate extrinsic pressure. Barium enema may show the colon pushed anteriorly or laterally. These roentgen studies help to differentiate between intra- and retroperitoneal and renal and extrarenal lesions. In the differential diagnosis one has to consider ovarian cyst, pancreatic or mesenteric cyst, intra-abdominal malignant disease, splenomegaly, renal tumors, pregnancy, and other types of retroperitoneal malignancy.[1,3]

This case is unique not only in its presenting diagnostic features but also in its unusual surgical problem.

Submitted for publication June 12, 1957.

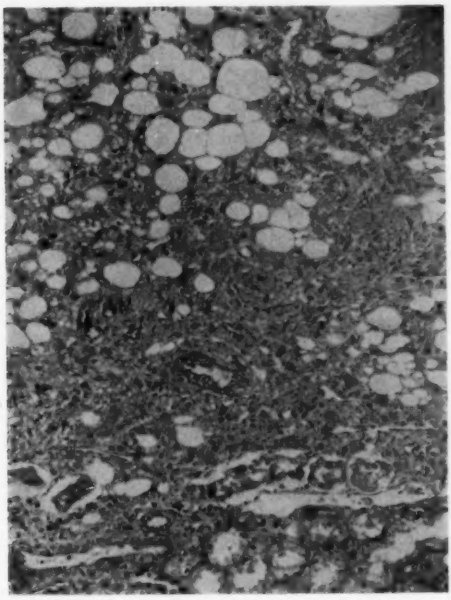
From the Lankenau Hospital, Surgical Service of Gilson Colby Engel, M.D.

Report of Case

A 30-year-old white woman was in good health until six and one-half hours prior to admission, on Dec. 20, 1947, when she developed severe right-sided abdominal pain, extending into her back and down her right leg. The patient noticed an enlarging lump in her right abdomen, beginning about one hour after onset of pain. The bowels had been perfectly regular. There were no abnormal menstrual or urinary symptoms. There was no history of previous operations. The patient had taken two enemas prior to admission, with no relief. Pain was only partially relieved by hypodermic injection given by the family doctor.

On admission the patient appeared pale and in shock. The blood pressure was 80/60 and the pulse 127. The heart and lungs were normal except for tachycardia. Abdominal examination revealed a diffuse mass on the right side, arising above the rest of the scaphoid contour. It measured approximately 4×8 cm. and was tender to touch and rather firm. There was no skin discoloration over the mass. Peristalsis was hypoactive on the left side and absent over the mass. Laboratory examinations showed 10 gm. of hemoglobin per 100 cc., with 3,000,000 red blood cells. Urinalysis was essentially normal.

Operation.—Intravenous fluids were started, including 500 cc. of blood. The patient was taken to the operating room, with a preoperative diagnosis of volvulus of the right colon or possible intussusception. Upon opening the abdomen through a right rectus incision, a large hemorrhagic tumor mass, apparently retroperitoneal, was seen pushing the right colon medially. There were numerous subserosal hemorrhages involving the entire right colon and the right one-third of the transverse colon. There were several dark, infarcted areas in the ascending colon. The rest of the abdominal viscera appeared normal. A right colectomy and ileotransversostomy were performed, using an end-to-side anastomosis. After removing the right colon, the large hemorrhagic tumor mass was seen to involve the lower pole of the right kidney. The tumor was removed en bloc with the right kidney. The retroperitoneal space was drained with a large cigarette drain and a soft rubber tube. The wound was closed with cotton. The patient's condition at the end of the operation was good.



Microscopic section taken of retroperitoneal tumor showing primitive lipoblasts and bizarre giant tumor cell forms.

Pathological Diagnosis.—Gross: The specimen consisted of the entire right colon and a portion of the transverse colon, which presented multiple infarcted areas but was otherwise normal. The tumor mass consisted of numerous irregular pieces of soft yellowish-pink tissue, the largest of which measured 10 cm. in diameter. Attached to the tumor mass was a normal-appearing kidney except for the lower pole, where there was a defect 3 cm. in diameter filled with brownish-yellow tissue, which grossly resembled the attached large tumor mass.

Microscopic: Histologic examination revealed the tumor to be composed of fully developed, adult fat cells intermixed with strands and bundles of various-sized, rounded and spindle-shaped cells with occasional bizarre giant-tumor-cell forms. Many of the cells in the less differentiated portion of the tumor revealed their true lipoblastic nature in that their cytoplasm was foamy or finely and irregularly vacuolated, with indented eccentrically placed nuclei.

Subsequent Course.—The patient's postoperative course was uneventful, with the highest temperature 100 F.[8] She was tolerating a soft diet on her seventh postoperative day and was discharged, feeling fine, 19 days after her admission. The patient has been followed every six months, with no evidence of recurrence. She was readmitted in June, 1951, for menorrhagia. A hysterectomy was performed for fibroid tumors. Careful exploration revealed no palpable recurrence of retroperitoneal tumor.

Comment

Moreland and McNamara reported 9 cases of liposarcoma occurring among 16,000 tumors. Von Wahlendorf Liebermann's series of 165 cases of retroperitoneal lipoma, of which 113 came to operation, showed malignant degeneration in 14%.[9] Stout was able to find only 7 retroperitoneal liposarcomas in 41 cases collected from the University of Columbia.[7] Careful microscopic examination of the tumor frequently reveals sarcomatous areas within the lipoma. There have been numerous incidences of reported benign lipoma in which later excision of a local recurrence showed sarcomatous change. Williams reported a 51 lb. retroperitoneal tumor which was diagnosed as a lipoma. Later a 10 lb. local recurrence was removed which was definitely sarcomatous. If repeated operation is necessary, as radical a procedure as possible should be done.

The rate of growth of these tumors is quite variable. Microscopically the better-differentiated ones simulate the ordinary embryonal fat, while the less-differentiated group simulates atypical embryonal lipoblasts with misshapen hyperchromatic nuclei. This latter group is more prone to metastasize through the blood stream. The amount of fibrous or myxomatous tissue present determines whether these tumors are termed lipofibrosarcoma, lipomyxosarcoma, or simply liposarcoma.[3] The age incidence of these tumors does not fall into any set pattern. Kretschmer reported a case of a 2-year-old child operated on for a retroperitoneal liposarcoma, with no recurrence three and one-half years postoperatively.

Deep x-ray therapy pre- or postoperatively has been of very little help in reducing the size of these tumors or of preventing recurrence. The newer chemotherapeutic agents to control recurrent or inoperable malignancy also have been disappointing.[3]

However, some of the polysaccharide compounds which are being developed may offer hope for this group of malignancies.[6] Primary radical resection, of course, still offers the best chance of cure.

Summary

A case is presented of a 30-year-old woman with hemorrhage complicating a retroperitoneal liposarcoma. The difficulty in preoperative diagnosis, as well as the complex surgical problems involved, are stressed. In the case presented this entailed right colectomy, right nephrectomy, and excision of the large retroperitoneal mass. A nine-year follow-up, with no recurrence to date, is reported.

Lankenau Medical Building, Lancaster Ave. & City Line (31).

REFERENCES

1. Cattell, R. B., and Warren, K. W.: Retroperitoneal Lipoma, S. Clin. North America 27: 659-665, 1947.

2. Cunnick, P. C.: Retroperitoneal Lipoma: A Case Report, Bull. School Med. Univ. Maryland 33:168-171, 1949.

3. Flynn, J. M.: Retroperitoneal Liposarcoma with Myxomatous Degeneration, Radiology 35:90-92, 1940.

4. Kretschmer, H. L.: Retroperitoneal Lipo-Fibro-Sarcoma in a Child, J. Urol. 43:61-74, 1940.

5. Moreland, R. B., and McNamara, W. L.: Liposarcoma: Report of 9 Cases, Arch. Surg. 45: 164-176, 1942.

6. Reiman, S. P.: Personal communication to the author.

7. Stout, A. P.: Liposarcoma—the Malignant Tumor of Lipoblasts, Ann. Surg. 119:87-107, 1944.

8. Williams, C.: Retroperitoneal Lipomyxosarcoma, J. A. M. A. 105:195-196, 1935.

9. Liebermann von Wahlendorf, A.: Über retroperitoneale Lipome, Arch. klin. Chir. 115:751, 1921.

Hemorrhagic Telangiectasia (Rendu-Osler-Weber Disease)

Report of Case Associated with Severe Repeated Gastrointestinal Hemorrhage

ARKELL M. VAUGHN, M.D.; MICHAEL S. WHITE, M.D., and GORDON H. McCOY, M.D., Chicago

Multiple, usually hereditary, hemorrhagic telangiectasis (hemorrhage telangiectasia) is a rare entity, although well recognized clinically in the last 35 years. The disease was first reported by Legg,[1] who in 1876 recorded the first case of inherited telangiectasis involving both the skin and the mucous membranes. However, little interest was aroused in the disease until, in 1896, Rendu[2] described a patient with repeated attacks of epistaxis who later displayed telangiectases of the skin of the face and mucous membranes of the mouth. Osler,[3] in 1901, reported three cases of the disease, the first report in this country, and in 1907 Weber[4] reported the disease, also called the Rendu-Osler-Weber syndrome.

The purpose of our case report is to put the physician and surgeon, when confronted with a case of severe gastrointestinal bleeding, on the alert to include, in the differential diagnosis, the possibility of multiple hemorrhagic telangiectasis.

The disease is usually prefixed by the terms hereditary, congenital, or familial. However, while heredity seems to be a dominant characteristic, as emphasized by Fitz-Hugh,[5] some authors, such as Christian,[6] Green,[7] and others, point out that not every case can be related to a direct familial or inherited history, and that the disease may by-pass several generations before reappearing. The sexes are equally affected by the disease, and persons of either sex may transmit it.

Initiated by some form of capillary weakness, this nonpurpuric and nonhemophilic disease is usually manifested by recurrent hereditary and nonhereditary epistaxis, hematemesis, bloody stools, and sometimes severe hemorrhage. Bleeding may also take place from the vessels of nevi, hemangiomata, or angiomata (Goldstein's heredofamilial angiomatosis). These last-mentioned bleeding sources may be of the skin or mucous membranes. They may be visible or may be detected only at autopsy.

The commonest sites of bleeding are the lips, tongue, surfaces of the hands and fingers, nasal septum, buccal mucosa, floor of the mouth, conjunctivae, eardrums and ears, palate, pharynx, and scalp. Bleeding may also originate in the intestine, bladder, liver, kidneys, trachea, esophagus and stomach, urethra, liver, and meninges. Boston[8] has stated that the lesions of telangiectasia increase in size, become more conspicuous, and are more frequently "the sites of hemorrhage with advancing years (after 40)." He states, however, that they rarely produce hemorrhage before the age of 10 years.

Splenomegaly, cirrhosis of the liver, periportal hypertension and fibrosis, biliary

Submitted for publication June 8, 1957.

From the Department of Surgery, Cook County Hospital, and the Vaughn Medical Group.

Clinical Professor of Surgery, Stritch School of Medicine of Loyola University; Professor of Surgery, Cook County Graduate School of Medicine; Attending Surgeon, Cook County Hospital; Attending Surgeon, Mercy Hospital (Dr. Vaughn). Clinical Instructor in Surgery, Stritch School of Medicine of Loyola University; Associate in Surgery, Cook County and Columbus Hospitals; Junior Attending Surgeon, Mercy Hospital (Dr. White). Surgical Resident, Cook County Hospital (Dr. McCoy).

dilatation, and venous congestion have been reported as concomitants of the Rendu-Osler-Weber syndrome, and of the nonfamilial and nonhereditary form of telangiectasia as well.

Report of Case

A Negro man, aged 72, had been admitted to the hospital 12 times in the past 18 years, 11 of these admissions being to Cook County Hospital. On each admittance the patient's complaint and immediate past history were of massive gastrointestinal bleeding. He had been admitted to a hospital in Ohio in 1939 with the complaint of vomiting blood and passing blood in the stool. At that time he received transfusions of 3 pints (1500 cc.) of blood. A roentgenogram had revealed no ulcer.

His first admission to the medical ward of Cook County Hospital was in May, 1947. He again complained of having vomited blood and passing bright-red blood per rectum. On this admittance he also complained of night pain and pain in the epigastrium when hungry. The admitting diagnosis was a bleeding peptic ulcer. A roentgenogram was negative for ulcer. There were no telangiectases visible. The patient was discharged with a diagnosis of hematemesis of undetermined origin.

The patient was admitted to the medical ward of Cook County Hospital once in 1950, twice in 1951, once in 1953, and five times in 1954, with an admitting diagnosis of Rendu-Osler-Weber disease. During his hospitalization in 1951 he had an exploratory laparotomy. A gastrostomy revealed no ulcer but did show capillary telangiectasia of the stomach and esophagus. He was discharged with a diagnosis of Rendu-Osler-Weber syndrome.

During his 1953 hospital stay, a proctoscopic examination was negative except for hemorrhoids. A gastroscopic examination, made by Dr. Leo Hart, of Cook County Hospital, revealed telangiectases in the esophagus and stomach. Each of the patient's last 10 admissions to Cook County Hospital were characterized by hematemesis and melena. Each time he received blood transfusions, with eventual cessation of bleeding.

The patient's last admission to the medical ward of Cook County Hospital was on March 1, 1957, with a complaint of having passed ½ pt. (250 cc.) of dark-red blood per rectum. The hematocrit on admission was 38%. He was started on diethylstilbestrol and vitamin K therapy. His hematocrit 12 hours later, however, had dropped to 27%. The patient was started on 1 unit of intravenous blood, and four hours later he had two voluminous dark-red bloody stools. Two hours later he had a second dark-red bloody stool, followed by coffee-grounds emesis. Over the succeeding 12 hours he received 5 units of blood intravenously. On the morning of March 3, two days after admission, his hematocrit had risen to 32%.

The patient was then given 2 cc. of epinephrine chloride (Adrenosem) intravenously. On the night of March 3 he started bleeding again, passing a dark bloody stool, and vomiting bright-red blood. His hematocrit dropped to 18% and his blood pressure from 150/90 to 100/70. On the morning of March 5, he received his 12th unit of blood but continued to bleed. He was at this time transferred to surgical service of one of us (A. M. V.).

On admission to the surgical ward the patient gave the impression of being a fairly well-nourished person, but with the appearance of one with secondary anemia. Physical examination revealed negative findings, and the liver and spleen were not enlarged. Blood pressure was 130/70 and the pulse rate 86 a minute. The hematocrit was 32%, and prothrombin, bleeding, and clotting times were all within normal limits. A roentgenogram taken at this time showed no ulcer niche or ulcer crater, but did reveal an irritable duodenal bulb and the possibility of a duodenal ulcer. The patient could give no familial or hereditary history of bleeding.

On the evening of March 5 the patient again passed a dark bloody stool. He was started on epinephrine hydrochloride therapy and was also given 1 Secule of conjugated estrogenic substances (Premarin Intravenous), equivalent to 20 mg. of sodium estrone sulfate, intravenously, followed by a second Secule one hour later.

The patient was seen by a hematology consultant, Dr. Steven O. Schwartz, and his associates, of Cook County Hospital. They reported the patient's prothrombin activity at 88%, the clotting time at 15 minutes, the bleeding time at 2 minutes, and the results of a Rumpel-Leede test as negative. The consultants advised an exploratory operation for a possible duodenal ulcer and also recommended that a gastric resection be performed. The patient, however, refused permission for surgical intervention.

While on our service, the patient was continued on Levin suction but no ulcer management was carried out. He apparently stopped bleeding, as evidenced by absence of melena or hematemesis. Telangiectases were present on the lips, tongue, floor of the mouth, and gingivae, but there was no evidence of any lesions on the mucous membranes of the nose.

A diagnosis of (probably) nonhereditary Rendu-Osler-Weber disease was made and confirmed by the hematology consultants. The patient was dis-

Fig. 1.—Photograph showing telangiectasis of the lower lip and gingiva.

Fig. 2.—Photograph showing telangiectasis of the lower lip and the base of the tongue.

charged on April 3. He had received 13,000 cc. of blood during his last hospital admission. Hematocrit at the time of discharge was 35%, and the patient was feeling quite well. He is seen routinely at the Cook County Hospital dispensary at weekly intervals and is now on a regimen of rutin, 60 mg., and ascorbic acid, 300 mg., three times daily, by mouth.

Comment

It is interesting to note that in the hereditary or nonhereditary type of hemorrhagic telangiectasia, the blood remains within normal limits except, of course, for evidencing a secondary anemia in certain patients. This was demonstrated in our case. Another exception is in cases when the blood loss is of such magnitude that hemorrhage may be of fatal consequence.

Likewise, our case would seem to demonstrate the need for differential diagnosis in the presence of gastrointestinal bleeding in a patient with or without a familial or hereditary history of hemorrhagic telangiectasia. As a matter of fact, Goldstein [9] has listed the diseases from which, in his opinion, Rendu-Osler-Weber disease must be differentiated. They include hemophilia, pseudohemophilia, thrombocytopenic purpura, leukemia, anemia, primary hypochromic anemia, myeloblastic hyperchromic anemia, hypertensive epistaxis, tuberculosis, cirrhosis of the liver, and malignant conditions.

Our case was interesting for the reason that, first, epistaxis, which is most commonly associated with hemorrhagic telangiectasia, was completely lacking as a symptom, and second, it was noticeable that a hemorrhage could be anticipated by the patient's marked state of confusion immediately prior to his vomiting blood or passing blood per rectum.

Summary

A case of hemorrhagic telangiectasia (Rendu-Osler-Weber syndrome) is reported. The patient suffered 12 recurrent attacks of gastrointestinal bleeding over an 18-year period. During all this time the blood picture remained essentially normal except for a secondary anemia.

The case is presented to emphasize the importance of including hemorrhagic telangiectasia in the differential diagnosis of gastrointestinal bleeding.

Epistaxis, one of the primary manifestations of the disease, was completely lacking in our case. Also, a familial or hereditary history was not established. It is pointed out, however, that this feature cannot always be found in an otherwise typical case.

2015 East 79th St.

REFERENCES

1. Legg, J. W.: Proceedings of Royal Medical and Chirurgical Society of London, Lancet 2:856, 1876.

2. Rendu: Épistaxis répétées chez un sujet porteur de petits angiomes cutanés et muqueux, Bull. mém. Soc. méd. hôp. Paris 13:731-733 (Oct. 23) 1896; cited by Green.[7]

3. Osler, W.: On Family Form of Recurring Epistaxis, Associated with Multiple Telangiectases of Skin and Mucous Membranes, Bull. Johns Hopkins Hosp. 12:333-337 (Oct.) 1901.

4. Weber, F. P.: Multiple Hereditary Developmental Angiomata (Telangiectases) of Skin and Mucous Membranes Associated with Recurring Hemorrhages, Lancet 2:160-162 (July 20) 1907.

5. Fitz-Hugh, T.: Importance of Atavism in Diagnosis of Hereditary Hemorrhagic Telangiectasia, Am. J. M. Sc. 166:884 (Dec.) 1923.

6. Osler, W.: The Principles and Practice of Medicine: Designed for the Use of Practitioners and Students of Medicine by H. A. Christian, New York, D. Appleton-Century Company, Inc., 1947, p. 977.

7. Green, R. E.: Rendu-Osler-Weber's Disease, U. S. Armed Forces M. J. 5:1365-1370 (Sept.) 1954.

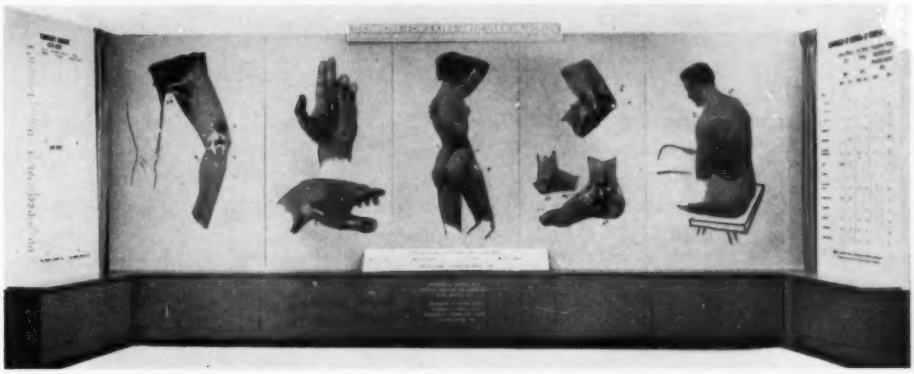
8. Boston, L. N.: Inherited Epistaxis Associated with Other Arterial Defects, M. Times 48:68-69 (March) 1930.

9. Goldstein, H. I.: Hereditary Multiple Telangiectasia, Goldstein's Heredofamilial Angiomatosis with Familial Hemorrhages or Rendu-Osler-Weber's Disease, Arch. Dermat. & Syph. 26:282-308 (Aug.) 1932.

Scientific Exhibits

Technique for Extra-Articular Injection

EUGENE G. LIPOW, M.D., Washington, D. C.; KENNETH M. KRON, M.D., and RICHARD T. SMITH, M.D., Philadelphia



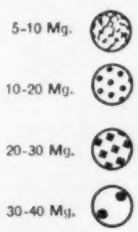
This exhibit processes the application of extra-articular injections of prednisolone tertiary butylacetate with or without hexylcaine hydrochloride for tendon, ligament, muscle, and bursal pathology of an acute or chronic nature which has been resistant to traditional therapy. It has been found that these injections tended to (1) alleviate muscle spasm, (2) reduce the inflammatory process, (3) decrease the pain, and (4) shorten the course of the disease and the duration of its disability.

The only contraindications are acute infections, blood dyscrasias, and malignancies.

The rational use of muscle relaxants, analgesics, and various modalities of physical therapy in conjunction with these extra-articular injections have made it possible to institute earlier muscle reeducation and motion. Hence, modality has been decreased and the period of rehabilitation substantially shortened.

Dosage

The dosage of prednisolone tertiary butylacetate (Hydeltra T. B. A., Merck, Sharpe & Dohme) is shown in the accompanying key. The dose of hexylcaine hydrochloride (Cyclaine HCl 1%, Merck Sharpe & Dohme) is 1 to 20 cc.



George Washington University (Dr. Lipow). Benjamin Franklin Clinic (Drs. Kron and Smith).

Shown as a scientific exhibit of the Section on Internal Medicine at the 105th Annual Meeting of the American Medical Association, New York, June 3-7, 1957.

Equipment

Syringes

2, 5, 10, and 20 cc.

Type is unimportant, but in general a Luer-Lok is recommended.

Needles

25-gauge; ¾″

23-gauge; 1 ½″

22-gauge; 3″, 4″, and 6″

20-gauge; 1 ½″ or 2″

16-gauge; 3″

Sterilization

Needles and syringes should be autoclaved daily and then kept in sterile containers until used.

Skin Sterilization

Skin sterilization is extremely important. The parts should be thoroughly cleansed, preferably by a two-minute scrub with soap and water, dried with alcohol and ether, and then thimerosal N. F. (Merthiolate) or other disinfectant applied.

Materials

Prednisolone tertiary butylacetate (Hydeltra-T. B. A.) Hexylcaine (Cyclaine) hydrochloride

General Instructions for Extra-Articular Injections

The choice of the length of the needle for extra-articular injections should be made with the objective of inserting the needle to its full length before injecting the prednisolone. A syringe containing hexylcaine HCl may be used for local infiltration before inserting the mixture of prednisolone tertiary butyl acetate and hexylcaine HCl.

In injecting in and around tendons, the needle should not pierce the tendon. The beveled portion of the point should lie on the tendon and the solution is then flooded on it while the needle is withdrawn.

No injection of material should be made until the plunger has been withdrawn to be certain that the needle is not in a blood vessel.

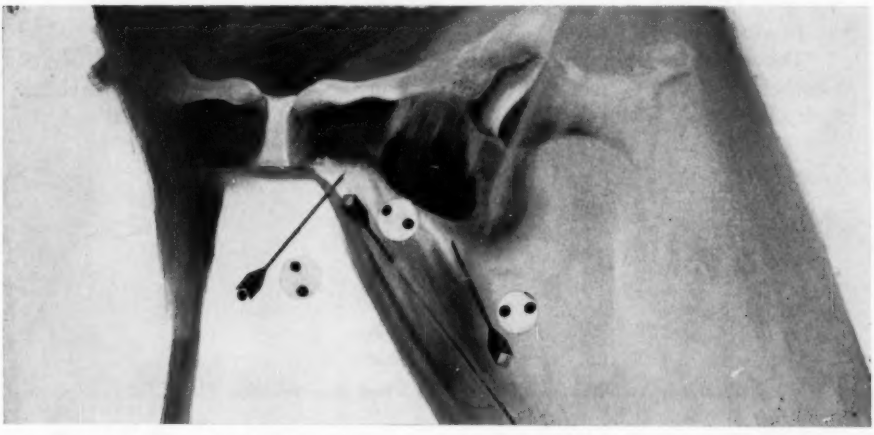


Fig. 1A.—Sites for injection placement of needles for adductor muscles and adductor muscle origins.

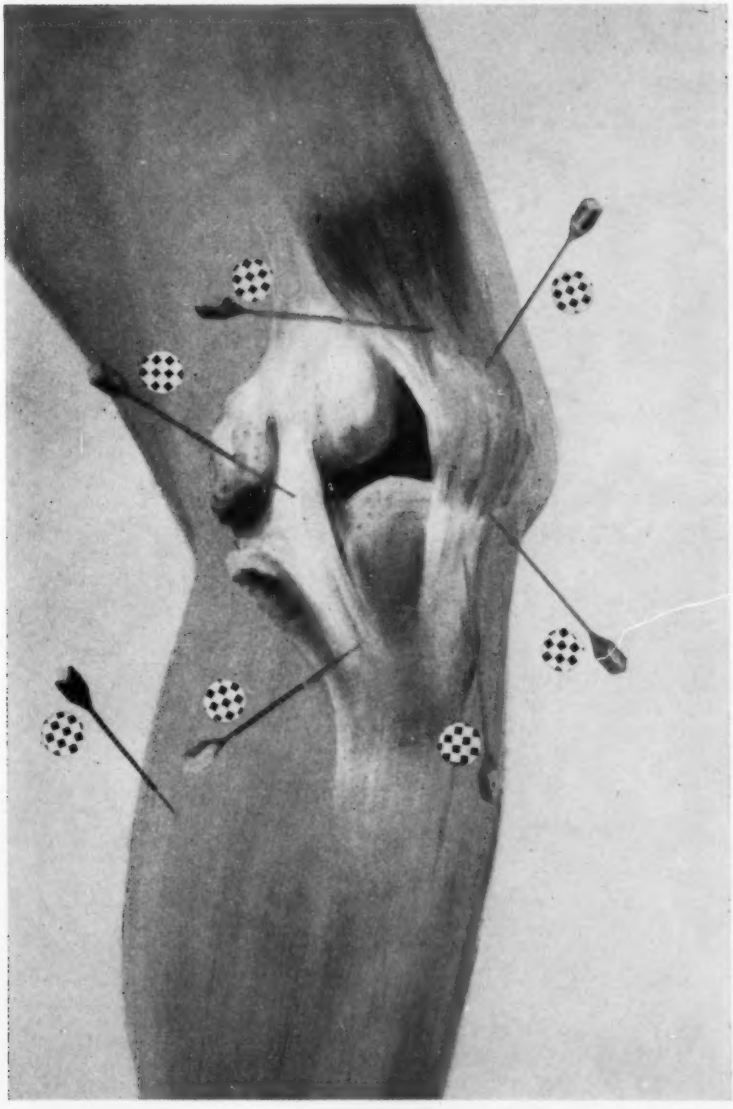


Fig. 1B.—Sites for injection and placement of needles for medical collateral ligament, patellar tendon, prepatellar bursitis, body of gastrocnemius muscle.

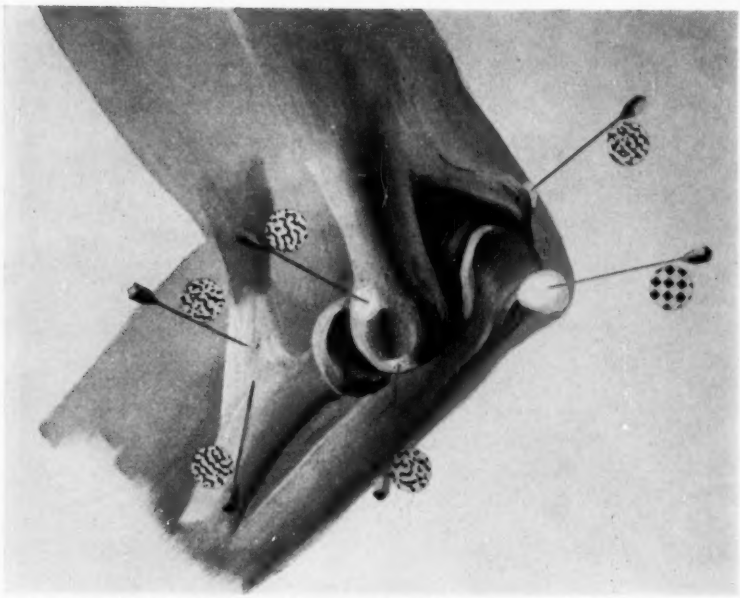


Fig. 2.—Sites for injection and placement of needles for epicondylitis, olecranon bursitis, radiohumeral bursitis, triceps strain, triceps tendonitis, bicipital tendonitis.

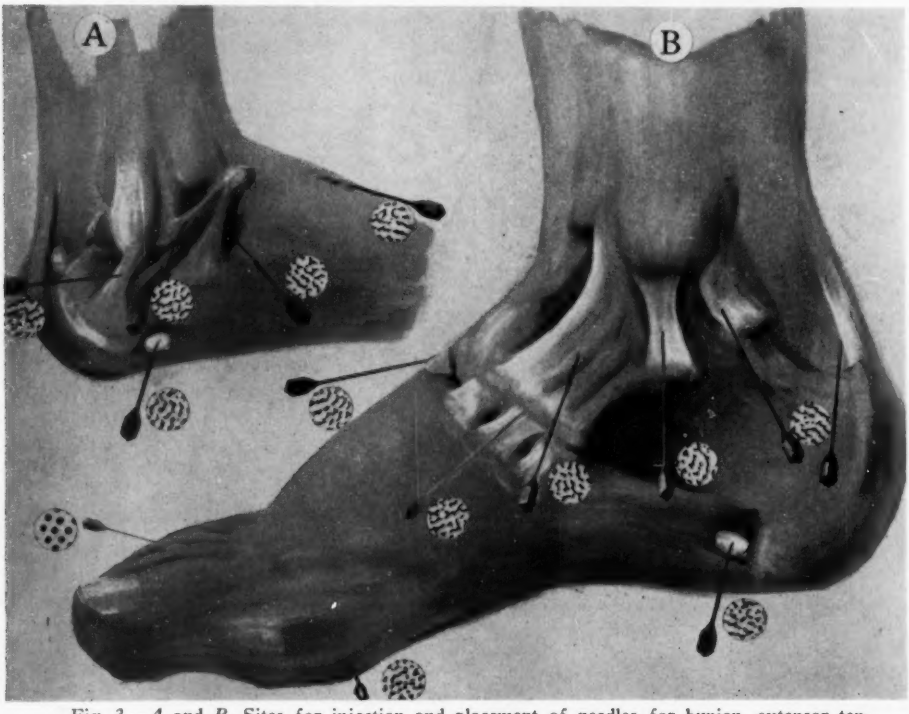


Fig. 3.—*A* and *B*, Sites for injection and placement of needles for bunion, extensor tendonitis of foot, subcalcaneal bursitis, retrocalcaneal bursitis, insertion of Achilles tendon, medial and lateral ligaments of ankle (sprains and strains), helomas of toes.

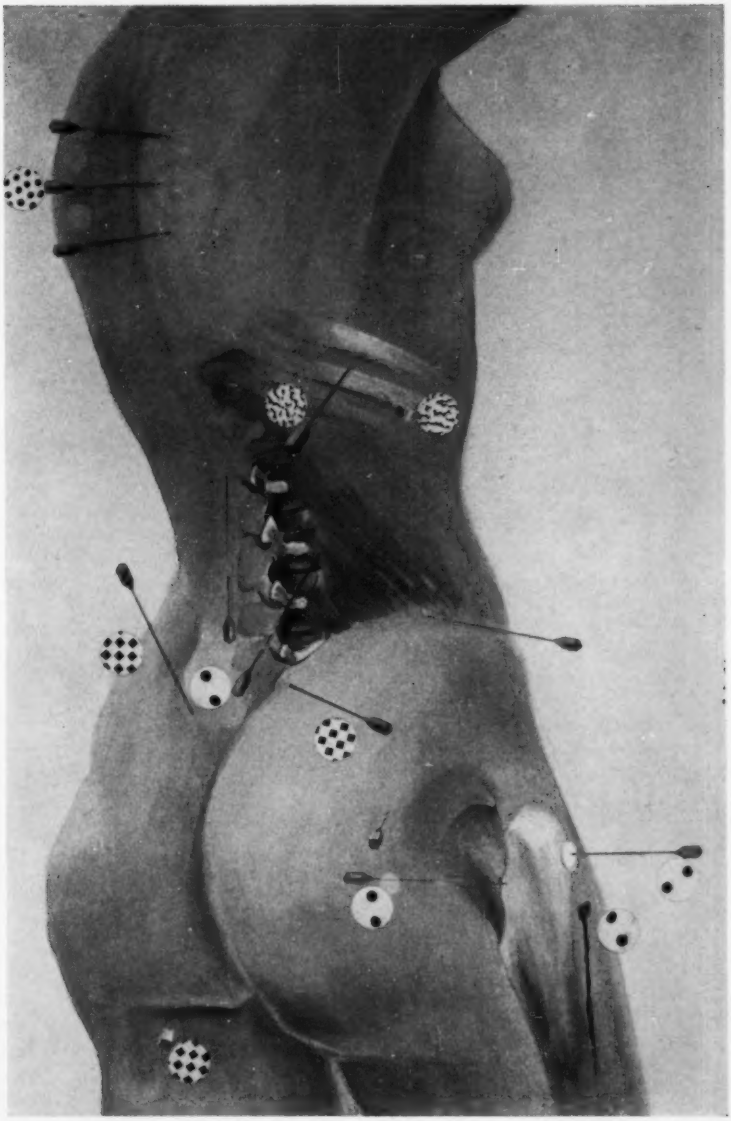


Fig. 4.—Sites for injection and placement of needles for trigger points on vertebral border of scapula, trigger points on ribs, intercostal neuritis or neuralgia, paravertebral blocks, bursae on superior posterior iliac spines, along sacroiliac synchondroses, posterior brim of pelvis—insertion of heavy muscle, trochanteric bursitis, fascia lata syndromes, sciatic nerve blocks, trigger points (sciatic) in buttocks.

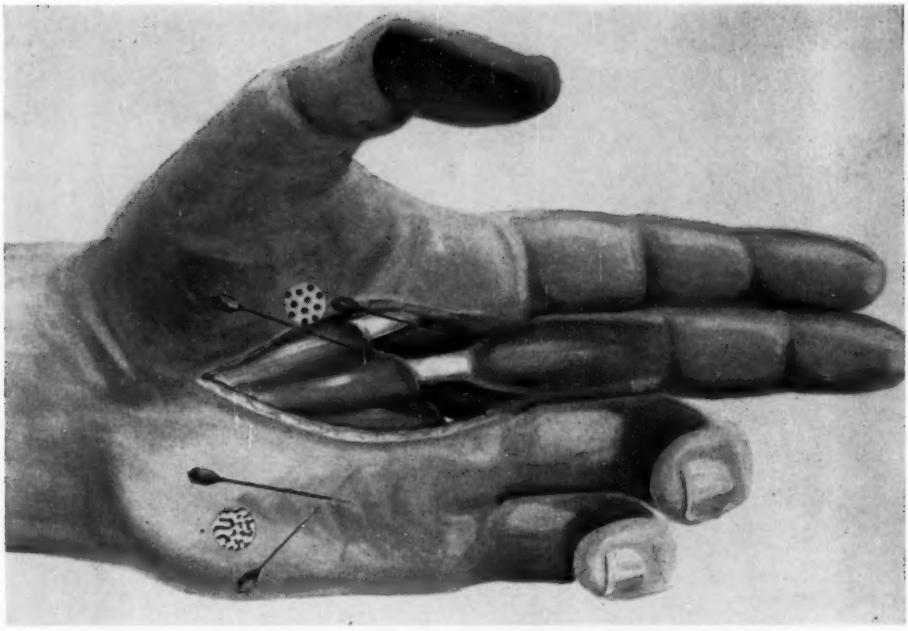


Fig. 5A.—Sites for injection and placement of needles for traumatic tenosynovitis or tendonitis of flexor tendons, "trigger finger," Dupuytren's contracture.

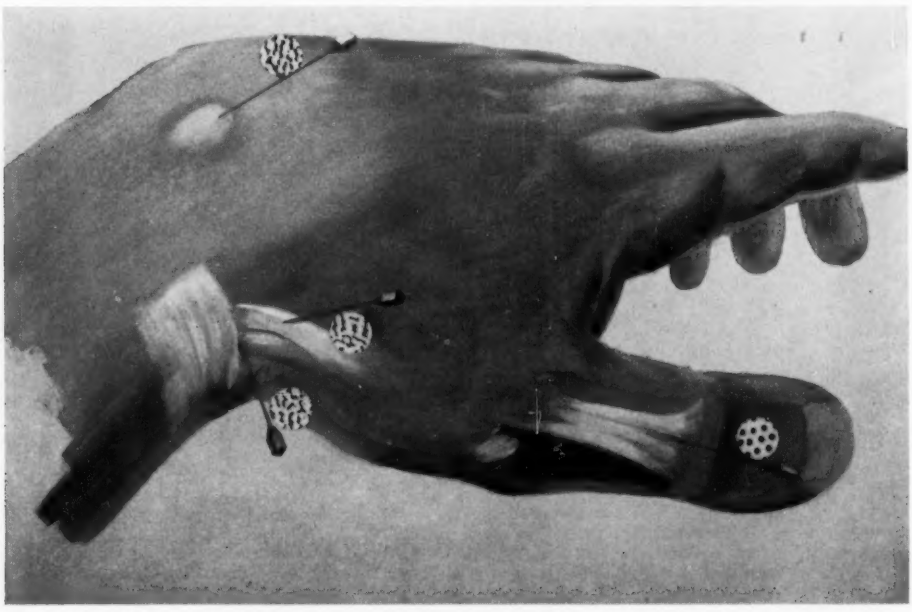


Fig. 5B.—Sites for injection and placement of needles for ganglion of wrist or dorsum of hand, de Quervain's stenosing tenosynovitis, abductor or extensor tendonitis of thumb.

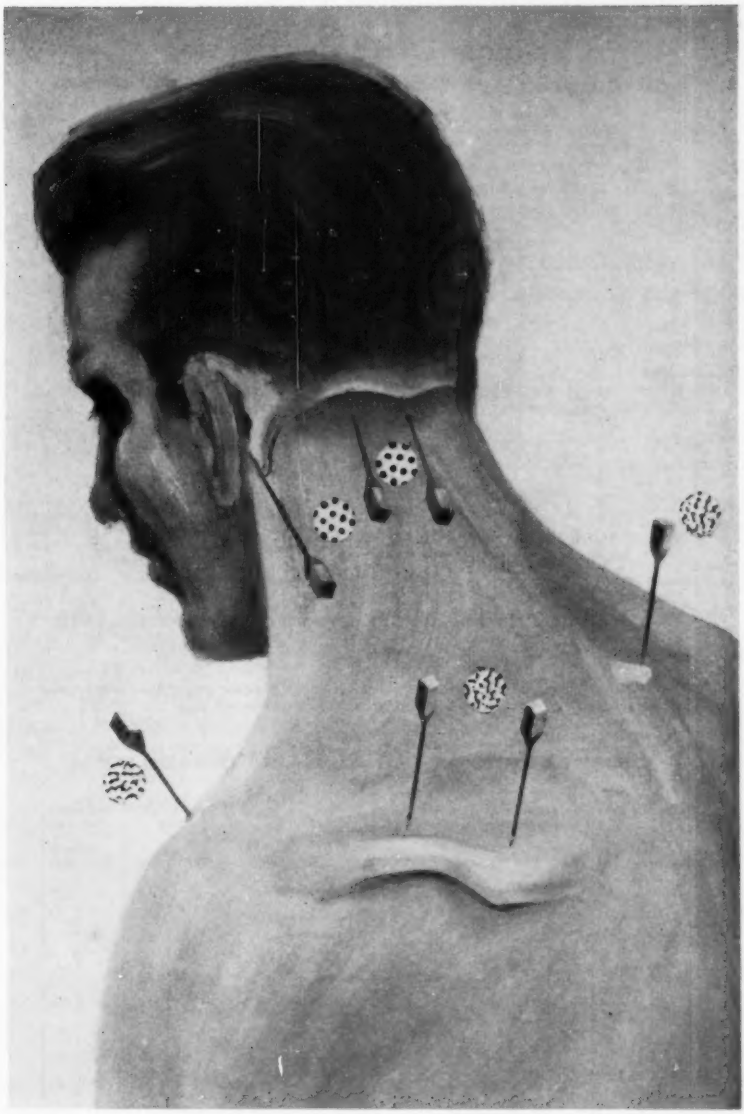


Fig. 6.—Sites for injection and placement of needles for trigger points in supraspinous portions of scapula, trigger points of the occiput, shoulder bursitis, spinous processes of cervical or dorsal vertebrae, origin of sternoclerdomastoid muscle.

CLINICAL EXPERIENCE

THERAPEUTIC RESPONSE

ACUTE ONSET

Condition	No. of Patients	Average No. Injections Required	Results Excellent and Good
Bursitis			
Subdeltoid	17	2	17
Subacromial	7	2	6
Olecranon	11	1+	11
Radiohumeral	5	3	4
Trochanteric	21	1+	20
Prepatellar	7	1	7
Navicular	1	1	1
Bunion	11	2	11
Calcaneal	8	2+	5
Strains and Sprains			
Wrist	6	1+	6
Collateral Ligament, Knee			
Medial	24	2	24
Lateral	5	2+	5
Foot and Ankle	12	2	11
Dorsolumbar	4	2	4
Lumbosacral	28	2	23
Sacroiliac	1	2	1
Epicondylitis	9	2	8
Muscle Injuries	4	2+	4
	181		168

This table indicates the conditions treated and the responses to this form of therapy.

SLOW ONSET

Condition	No. of Patients	Average No. Injections Required	Results Excellent and Good
Trigger Points			
Adductor Muscles, Thigh	3	2	3
Back	47	1+	34
Intercostal	17	2	17
Trigger Finger	32	1+	32
Dupuytren's Contracture	6	3	3
Tendinitis			
Bicipital	5	2	5
Digital	5	2	5
Extremities	4	2	4
Tenosynovitis (non-suppurative)	18	2	16
Tensor Fascia Lata Syndrome	8	2+	7
Whip-lash, Neck, Residuals	6	1	6
Ganglion	13	1+	13
Rheumatoid Nodule	9	2+	7
Coccydynia	2	2	2
Radiculitis			
Peroneal Palsy	2	2+	1
Sciatic Syndrome	2	2	2
Others	9	1	7
Capsulitis	7	2	6
Frozen Shoulder	7	3+	5
Fibrositis	14	2	12
Peritendinitis	3	1	3
	219		190

Total Number of Patients 400 **Total Number Benefited 358**

Fig. 7.—Table indicating conditions treated and responses to this form of therapy.

This table indicates a comparison of the responses to the various forms of therapy as compared with extra-articular injection techniques with prednisolone tertiary butylacetate and hexylcaine hydrochloride.

COMPARISON OF DURATION OF DISABILITY

	General Medical Care DAYS		Oral Steroid Therapy DAYS		Prednisolone Tertiary Butylacetate and Hexylcaine Injection DAYS	
	Relief	Cure	Relief	Cure	Relief	Cure
Bursitis						
Subdeltoid	10	30	5	21	1	8
Trochanteric	12	45	6	30	1	15
Calcaneal	6	30	6	30	1	15
Dorsolumbar Sprain	3	30	3	30	1	12
Bicipital Tendinitis	10	30-50	6	30	2	15-20
Sprain of Medial Collateral Ligament	21	60	15-21	60	3-5	20
Ganglion	1 (surgery)	10			1	5
Tenosynovitis	7	15	5	15	1	7
Tensor Fascia Lata Syndrome	10	45	10	45	2	20
Intercostal and Rib Pain	10-20	10-20			1	5
Sciatic Syndromes	10	25	7	25	4	15
Muscle Injuries	20	40	20	40	5	25
Lumbosacral Sprains	15-25	40	15	40	5	20
Tendonitis of Extremities	12	20	12	20	2	10

NOTE: All supportive measures including physical therapy, splinting and bandaging were used in each of the above types of treatment

Fig. 8.—Table indicating a comparison of the responses to the various forms of therapy as compared with extra-articular injection techniques with prednisolone tertiary butylacetate and hexylcaine hydrochloride.

All of
these articles have
appeared in TODAY'S HEALTH
and are now available
in one pamphlet.

ALCOHOLISM

an
important
problem
in today's living

ALCOHOLICS ANONYMOUS

Written from the standpoint of a member, the basic treatment procedures are described and the psychological problems confronting the alcoholic are discussed.

ALCOHOL AND CIRRHOSIS OF THE LIVER

Relationship between alcohol, diet and cirrhosis. Increasing stress on nutritional differences.
by Russell S. Boles

HOW TO HELP A PROBLEM DRINKER

Understanding the alcoholic's capabilities, the necessity of help, causes of his condition.
by Edward A. Strecker and Francis T. Chambers, Jr.

THE TREATMENT OF ALCOHOLISM

Tracing the steps from convincing the alcoholic that he is sick through treatment and cure.
by Lewis Inman Sharp

CONDITIONED REFLEX TREATMENT OF CHRONIC ALCOHOLISM

Its place among methods of treatment today, its development and correlation with personality factors.
by Walter L. Voegtlin

INSTITUTIONAL FACILITIES FOR THE TREATMENT OF ALCOHOLISM

Comparative differences, in drinking, with the last century, new establishments and methods of treatment, lack of trained personnel.
by E. H. L. Corwin

THE ABOVE SIX PAMPHLETS ARE AVAILABLE IN BOOKLET FORM FOR ONLY 50 CENTS

HOW EXPERTS MEASURE DRUNKENNESS

A partial transcript of an actual courtroom case.
H. A. Heise
8 pages, 15 cents

BARBITURATES, BOOZE AND OBITUARIES

A discussion of the dangers of mixing alcohol and barbiturates.
Donald A. Dukelow
4 pages, 10 cents

ADDRESS REQUESTS TO:

ORDER DEPARTMENT
AMERICAN MEDICAL ASSOCIATION
535 NORTH DEARBORN STREET
CHICAGO 10, ILLINOIS

YOUR
GUIDE TO
CURRENT PUBLICATIONS

Quarterly Cumulative Index Medicus

WITH AUTHORS AND SUBJECTS . . .

Divided into sections, one devoted to books and the other to periodical literature, the QUARTERLY CUMULATIVE INDEX MEDICUS contains a list of current publications alphabetized as to authors and subjects. The exact bibliographic reference is given under the author with titles in the original language, while titles under subjects are all in English. The index also includes a listing of journals, addresses and publishers.

The QUARTERLY CUMULATIVE INDEX MEDICUS appears twice a year; volumes are cloth bound and cover periodicals for six months as indicated on the publication. These two volumes will be a convenient and inclusive reference for current medical literature. Invaluable for practitioners, specialists, teachers, editors, writers, investigators, students and libraries.

SUBSCRIPTION PRICE $25.00 PER YEAR
CANADIAN AND FOREIGN $27.00 PER YEAR

AMERICAN MEDICAL ASSOCIATION
535 NORTH DEARBORN STREET
CHICAGO 10, ILLINOIS

What's delaying his convalescence?

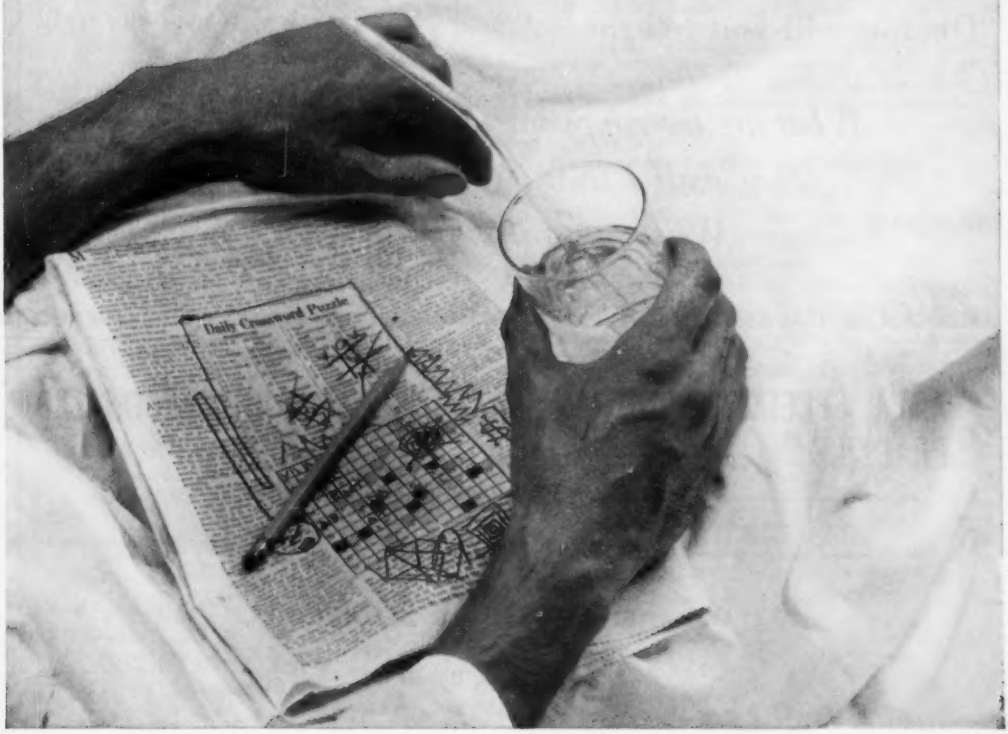
Worry. About the operation he's just had—will it be successful? About his job—the boss said nothing would be changed, but did he really mean it?

You will find that 'Dexamyl' helps combat post-operative "blues" and worry. Dexamyl's smooth, "normalizing" action frequently replaces mild depression with a feeling of confidence and optimism. '*Dexamyl' encourages convalescence.*

A combination of Dexedrine* (dextro-amphetamine sulfate, S.K.F.) and amobarbital, Dexamyl* is available as tablets, elixir and Spansule* sustained release capsules.

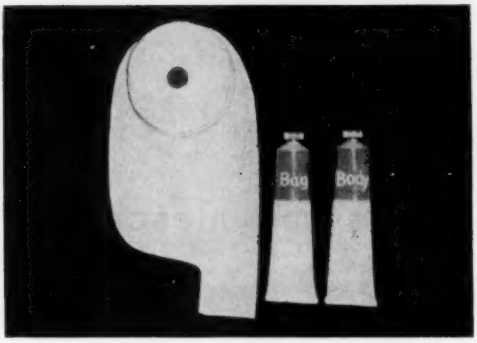
Smith, Kline & French Laboratories, Phila.

*T.M. Reg. U.S. Pat. Off.



CUSTOM MADE

RUBBER ILLEOSTOMY COLOSTOMY APPLIANCES



- CHEMICALLY TREATED TO HELP ELIMINATE ODOR.
- CEMENTED TO BODY WITH OUR SPECIAL ADHESIVE CEMENT.

For information write to:

GERARD PRODUCTS

Dept. A

7875 Oakleaf Ave., Elmwood Park, Chicago 35, Ill

Viokase Pancreatin 4 times the N.F. X minimum potency standards.

VIOKASE

WHOLE PANCREAS
Not an extract!

EFFECTIVE substitution therapy in demonstrated pancreatic deficiency.

NOT ENTERIC COATED

Jordan and Grossman; Arch. Surg. 74: 871, 1957

Shingleton, et al; Surgery, 42: 12, 1957

Longmire, Jordan and Briggs; Ann. Surg. 144: 681, 1956

Krane; Am. Pract. and Digest, 8: 1275, 1957

Literature on request.

VIOBIN, Monticello, Illinois

"Doctor, will you tell me..."

What are the symptoms?
How shall I treat it?
What causes it?

For practical information about communicable disease, have your patients read:

SCARLET FEVER
8 pages, 15 cents

IMMUNIZATION
by Ruth A. Thomas, 8 pages, 15 cents

WHOOPING COUGH
by Constance Frick, 4 pages, 10 cents

PNEUMONIA'S WATERLOO?
by William W. Bolton, 12 pages, 15 cents

WE CAN PREVENT DIPHTHERIA
by P. S. Rhoads, 8 pages, 15 cents

AMERICAN MEDICAL ASSOCIATION • 535 NORTH DEARBORN • CHICAGO 10

A.M.A. SPECIALTY JOURNALS REACH THE CORE OF SPECIALIZED PRACTICE . . . *Subscribe NOW to:*

→ A.M.A. Archives of INTERNAL MEDICINE
→ A.M.A. Archives of PATHOLOGY
→ A.M.A. Archives of OPHTHALMOLOGY

Write to:

THE AMERICAN MEDICAL ASSOCIATION
535 North Dearborn Street
Chicago 10, Illinois

A. M. A.
AMERICAN JOURNAL
OF
DISEASES OF
CHILDREN

integrate your knowledge—
subscribe to

A. M. A. Archives of
PATHOLOGY

A. M. A. Archives of
INTERNAL MEDICINE

A. M. A. Archives of
OPHTHALMOLOGY

A. M. A. Archives of
OTOLARYNGOLOGY

For a more complete reference shelf, we recommend these related journals. The variety of fields covered are especially appealing to the general practitioner with special interests. Each issue is important to your practice. Begin your subscriptions TODAY.

Department (D. C.)
AMERICAN MEDICAL ASSOCIATION
535 N. Dearborn St.
Chicago 10, Ill.

Begin my subscription(s) NOW, for:

A. M. A.....

NAME.....

STREET.....

CITY.....STATE.....

new SUPER HEADLIGHT

BY GOOD-LITE

- COOLER OPERATION
- 9 INTENSITIES OF LIGHT
- INCREASED SAFETY—
  UNDERWRITERS APPROVED

Medical men who have tried the new Super Good-Lite tell us there's nothing like it anywhere . . . at any price! Here's why: The entire unit has been redesigned by a group of *practicing surgeons* to provide a beam of light both brilliant and controllable . . . featuring nine intensities of light. The headlight construction and electrical circuit was designed for cooler operation and maximum safety.

The Good-Lite SUPER Headlight Includes:

- Good-Lite parallel beam headlight.
- 3 types of bulbs with 3 intensities of light each.
- Special Ground lens to intensify light.
- 2 mirrors (peep-hole and plain).
- Heavy duty transformer (20 watt) with 3 positions and off switch. Fuse in the secondary for your safety.
- Molded plastic connections.
- Gray plastic stainproof cords.
- Choice of 5 types of headbands.

Consult Your Surgical Supply Dealer or Send Coupon Today

GOOD-LITE MFG. CO.
7638 W. Madison St. • Forest Park, Ill.

Please send free catalog on Good-Lite Headlights to:

Dr._____

Address_____

City_____ Zone_____ State_____

YOUR
GUIDE TO
CURRENT PUBLICATIONS

Quarterly Cumulative Index Medicus

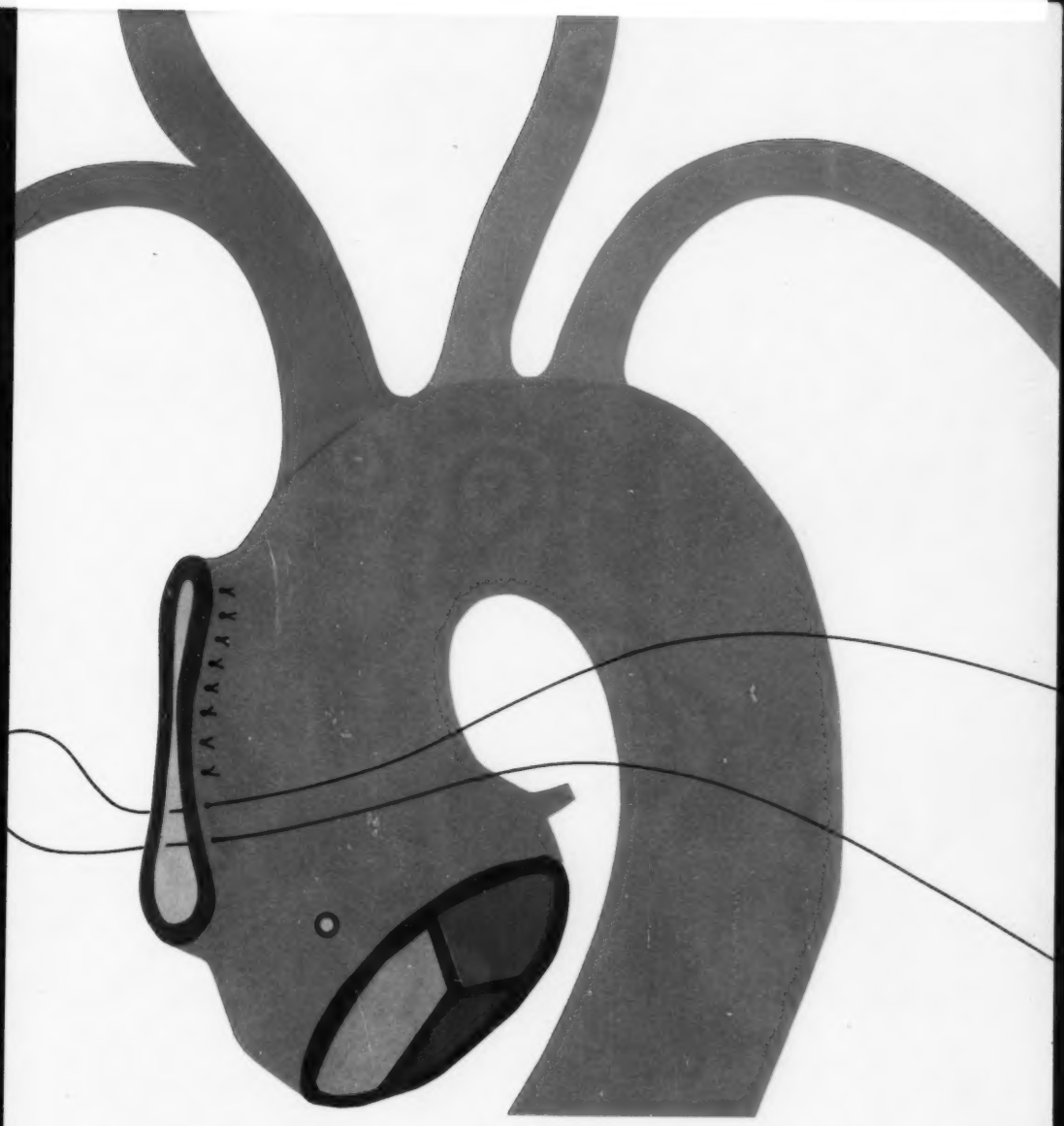
WITH AUTHORS AND SUBJECTS . . .

Divided into sections, one devoted to books and the other to periodical literature, the QUARTERLY CUMULATIVE INDEX MEDICUS contains a list of current publications alphabetized as to authors and subjects. The exact bibliographic reference is given under the author with titles in the original language, while titles under subjects are all in English. The index also includes a listing of journals, addresses and publishers.

The QUARTERLY CUMULATIVE INDEX MEDICUS appears twice a year; volumes are cloth bound and cover periodicals for six months as indicated on the publication. These two volumes will be a convenient and inclusive reference for current medical literature. Invaluable for practitioners, specialists, teachers, editors, writers, investigators, students and libraries.

SUBSCRIPTION PRICE $25.00 PER YEAR
CANADIAN AND FOREIGN $27.00 PER YEAR

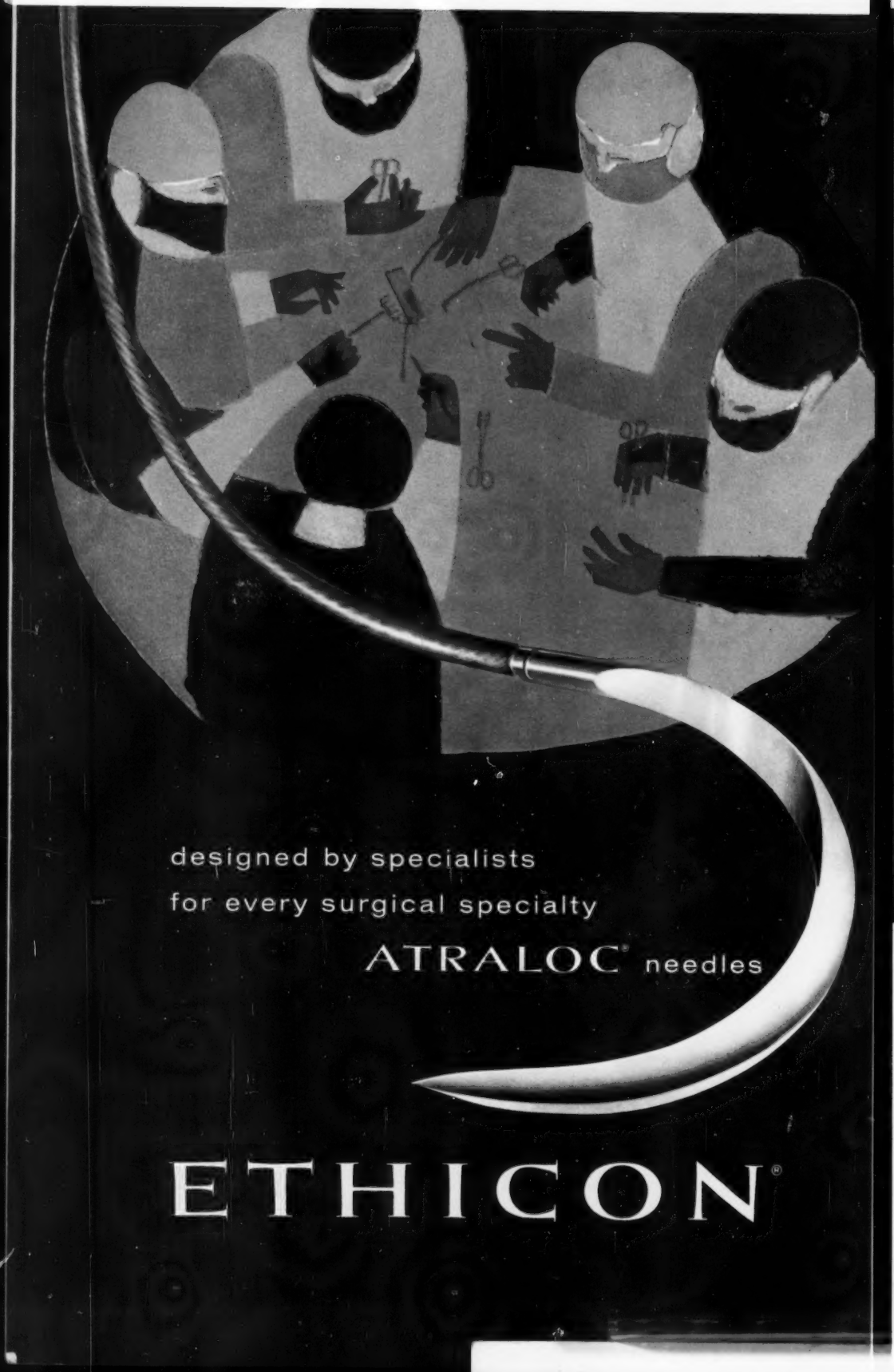
AMERICAN MEDICAL ASSOCIATION
535 NORTH DEARBORN STREET
CHICAGO 10, ILLINOIS



setting new standards

ETHICON®

sutures


designed by specialists
for every surgical specialty
ATRALOC® needles
ETHICON®

now available!

SteriSharps®

the first sterile, stainless-steel surgical blade

new SteriSharps valuable aid to surgeons and nurses...saves time, eliminates blade waste

Now available—the new SteriSharps surgical blade. Made of stainless steel, it has the sharpest, most uniform, most durable cutting edge made today. Comes to you ultrasonically cleaned and heat-sterilized for asepsis. Saves time, simplifies technic.

Surgeons can depend on *consistent sharpness* with SteriSharps. Electronic tests by ASR Sharpometer® assure uniform sharpness.

SteriSharps offer important economies, too. With SteriSharps only blades actually needed are used. They're unaffected by autoclaving, dry heat, solutions. Sealed packets can be re-autoclaved, stored indefinitely.

For details, write: ASR Hospital Division, Dept. AA, 380 Madison Ave., N. Y. 17, N. Y.

Blade Dispenser available. Your supplier has SteriSharps surgical blades in every design. Stainless steel dispenser shown above is yours free with every five gross.

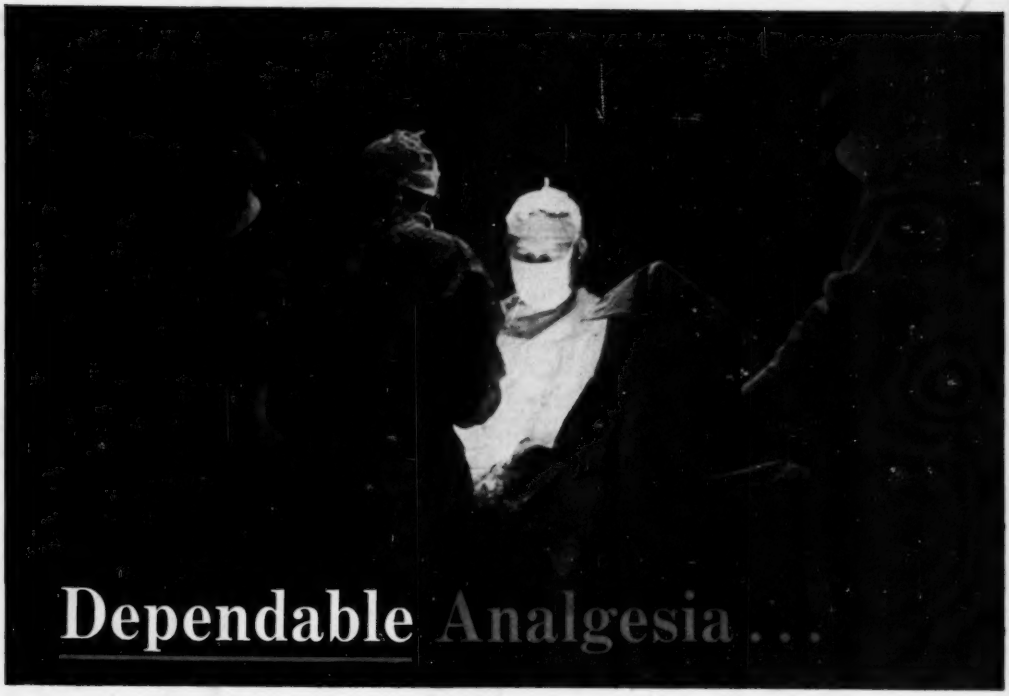
Only SteriSharps offer all these advantages...

Sharpest, most durable cutting edge • Consistent sharpness in every blade • SteriSharps will not corrode
Can be re-autoclaved, stored in packs • Sterile SteriSharps eliminate jars, racks and irritating solutions

A·S·R precision products

SteriSharps... the first sterile, stainless-steel surgical blade

precision products



PROFOUND • PROLONGED • CONTROLLED

with Pontocaine®

hydrochloride

SADDLE BLOCK

0.2% Pontocaine HCl in dextrose (hyperbaric) ampuls of 2 cc. (4 mg.) Also "Niphanoid"® (instantly soluble dry form) and 1% solution in saline (isobaric)

SPINAL

HIGH
MEDIUM
LOW

0.3% Pontocaine HCl in dextrose (hyperbaric) ampuls of 5 cc. (15 mg.)

"Niphanoid," ampuls of 10, 15 and 20 mg.

1% solution (in saline) 2 cc. (20 mg.)

NERVE BLOCK AND INFILTRATION

0.15% solution, vials of 100 cc.

"Niphanoid," ampuls of 250 mg.

Winthrop **LABORATORIES**
NEW YORK 18, N. Y. • WINDSOR, ONT.

Pontocaine (brand of tetracaine) and Niphanoid, trademarks reg. U.S. Pat. Off.